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ABSTRACT

This report provides an overview of the scientific missions, research and research training funding trends, strategic planning initiatives, and research highlights for each Child Development and Behavior Branch (CDBB) research program for the years 1995-1999. CDBB develops scientific initiatives and supports research and research training relevant to the psychological, psychobiological, and educational development of children from conception through adolescence. A central theme flowing through all of the Branch scientific program areas is that physical and behavioral development are most adequately and accurately described as variable processes in which individual differences in cognitive, social, affective, language, and neurobiological maturation, environment and life experiences, and genetics interact in complex ways to influence child development. The five scientific research program areas are described, which include: (1) the Program in Cognitive, Social, and Affective Development; (2) the Program in Developmental Psychobiology and Cognitive Neuroscience; (3) the Program in Behavioral Pediatrics and Health Promotion; (4) the Program in Human Learning and Learning Disabilities; and (5) the Program in Language, Bilingualism, and Biliteracy Development and Disorders. Appendices include a list of major conferences and workshops conducted during the past five years and requests for applications and program announcements published by the Branch. (Contains 12 references.) (CR)

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Child Development and Behavior Branch

NICHD

ED 448 543

Report to the NACHHD Council

June 2000

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EXECUTIVE SUMMARY

The Child Development and Behavior Branch (CDBB) develops scientific initiatives and supports research and research training relevant to the psychological, psychobiological, and educational development of children from conception through adolescence. A central theme flowing through of all Branch scientific program areas is this: physical and behavioral development are most adequately and accurately described as variable processes in which individual differences in cognitive, social, affective, language, and neurobiological maturation, environment and life experiences, and genetics interact in complex ways to influence child development.

During the past five years, the Branch developed initiatives to better understand how inherited, dispositional, environmental, and experiential conditions are integrated in development to mold, moderate, and predict human learning and behavior. Critical to these initiatives is an emphasis on the development of dynamic research methods and approaches that assess and describe complex behavioral and biological interactions as they unfold over time. Concurrently, in the past five years, the Branch developed and initiated new lines of research to emphasize and address issues of causality, particularly with respect to the timing, scope, interaction, and impact of well-defined environmental, experiential, neurobiological, and genetic factors on individual differences in cognitive, social, emotional, language, and academic development.

All CDBB initiatives are based on important, extensive, and long-term collaborations between Branch scientific staff and the extramural scientific community. These formal collaborations are operationalized at Branch-supported multidisciplinary conferences and workshops. The major purpose of these collaborations is to identify critical gaps in the extant knowledge base within a selected programmatic portfolio; prioritize specific research targets for investigation; and delineate theoretical and conceptual models and methodological strategies that can be brought to bear in closing the gaps in our knowledge of child development. Appendix A provides a list of the major conferences and workshops conducted during the past five years. Appendix B lists the Requests for Applications (RFAs) and the Program Announcements (PAs) published by the Branch to stimulate critically needed research.

To better serve its scientific constituencies and accomplish its scientific missions, the Branch has reorganized its research programs to increase focus, coherence, and relevance. The Branch has successfully recruited accomplished and experienced scientists to direct each of the research programs. Brief biographical sketches of Branch staff are provided in Appendix C. A list of Branch program directors' publications spanning the past five years is provided in Appendix D.

This report provides an overview of the scientific missions, research and research training funding trends, strategic planning initiatives, and research highlights for each CDBB research program for the years 1995-1999. Please note that funding amounts are reported in current dollars rather than constant dollars, which reflect an 11.4 percent decrease in value since 1995.

OVERVIEW OF CDBB FUNDING TRENDS: 1995-1999

The CDBB is composed of five scientific research program areas, including the Program in Cognitive, Social, and Affective Development; the Program in Developmental Psychobiology and Cognitive Neuroscience; the Program in Behavioral Pediatrics and Health Promotion; the Program in Human Learning and Learning Disabilities; and the Program in Language, Bilingualism, and Biliteracy Development and Disorders.

The total CDBB budget in 1999 was $53,577,705 (see Table 1). This amount reflects a 43 percent increase in funding awarded across mechanisms since 1995. The total number of grants supported by the Branch increased 13 percent over the past five years, from 175 grants awarded in 1995, to 198 grants funded in 1999 (see Table 2). Total funding for all 976 grants for the 1995-1999 period was $235,186,934.

Funding for research grants (i.e., R01, R03, P01), excluding research centers (P50), has followed a similar, albeit lower, trend. In 1995, CDBB spent $29,706,839 for research grants; in 1999 the amount increased 33 percent to $39,514,214 (Table 3). The number of research grants supported over the five-year period increased 10.7 percent, from 122 in 1995, to 135 in 1999 (see Table 4). During this five-year reporting period, 649 research grants were awarded at a total cost of $178,752,877. Thus, funding for research grants accounted for 76 percent of the total Branch funding and 67 percent of the number of grants funded from 1995-1999.

Figure 1 indicates that total funding over the past five years increased in the Program in Human Learning and Learning Disabilities, the Program in Cognitive, Social, and Affective Development, and the Program in Behavioral Pediatrics and Health Promotion, with stable trends noted for the Program in Developmental Psychobiology and Cognitive Neuroscience and the Program in Language, Bilingualism, and Biliteracy Development and Disorders during the same time period. Figure 2 indicates that the number of grants awarded from 1995-1999 increased most dramatically (150 percent) for the Program in Behavioral Pediatrics and Health Promotion Research (denoted as Health on all figures), followed by the Program in Human Learning and Learning Disabilities (22 percent). The other three research programs report no significant increase or decrease in total grants awarded (Figure 2).

Funding specifically for research grants (i.e., R01, R03, P01) also increased substantially from 1995-1999 in the Program in Human Learning and Learning Disabilities Program and the Program in Behavioral Pediatrics and Health Promotion; the remaining programs reported stable trends (Figure 3) for research grant funding during this time. These same trends are noted in the numbers of grants supported by each program area (Figure 4).

In general, funding trends for CDBB from 1995-1999 reflect a moderate increase in the number of grants awarded (12 percent) and a substantial increase in the cost of those grants (43 percent). The same trends are noted for investigator-initiated research grants, which account for over 76 percent of the total Branch portfolio. The remainder of this report provides specific funding trends for the period 1995-1999 for each research program area, in addition to summaries of the scientific missions, strategic planning initiatives, and research highlights relevant to each program.

THE PROGRAM IN COGNITIVE, SOCIAL, AND AFFECTIVE DEVELOPMENT

SCIENTIFIC MISSION

The Program in Cognitive, Social, and Affective Development conceptualizes, initiates, and supports scientific efforts designed to advance knowledge in normative cognitive, social, affective, and personality development in children, from the newborn period through adolescence. Within this context, the program seeks to stimulate and support research relevant to the impact of specific aspects of physical, social, cultural, and biological environments and factors on the health and psychological development of infants, children, and adolescents. Over the last two years, this program developed new initiatives to identify the ecological, psychosocial, and biological antecedents and consequences of child abuse and neglect and to discover and define the mechanisms by which child abuse and neglect result in harmful effects to the child and the family. The program's leadership role in spearheading and organizing an NIH- and Federal agency-wide (DHHS, Education, Justice) initiative to develop reliable and valid definitions of child abuse and neglect is central to these initiatives.

FUNDING TRENDS

Research Grants. From 1995-1999, the Program in Cognitive, Social, and Affective Development has been the largest in the Branch, in terms of the number of research grants supported, representing between 33 percent and 42 percent (depending on the year) of the total CDBB research and research training portfolio (Figure 2, Developmental). Grants supported by this program also account for the largest portion of the total CDBB research budget, representing between 25.8 percent and 32.9 percent of the Branch expenditures, depending on the year (Figure 1).

Since 1995, the program has grown in terms of research funding (Table 3, Developmental) and the number of research grants that have been funded. Specifically, funding has increased 9.6 percent since 1995, when expenditures totaled $9,770,372, compared with $10,054,501 awarded in 1999. Likewise, the number of research grants funded has increased modestly, with 54 awards made in 1999, in contrast to 51 awards in 1995 (Table 8). This increase is significant, however, in that it can be accounted for by grants awarded to new investigators. Several other types of grants were also awarded: FIRST award grants (R29), Small Grants (R03), MERIT Awards (R37), and Small Business grants (SBIR), Shannon Awards, cooperative agreements, research contracts, research conferences (R13), and interagency agreements. Of all the grants awarded during the past five years, 45 percent have been new awards as opposed to either competing or non-competing continuation awards.

Cognitive Development. Research in cognitive development was the largest scientific area funded by the program, representing approximately 48 percent of the total portfolio. Of all of the scientific domains supported by the program, research in cognitive development also showed the greatest increase in funding and number of grants supported

over the last five years (Figures 5-6, Tables 5-6). Note that for purposes of analysis of the three subdivisions of this program, awards are discussed as research vs. training. Thus "research" in these discussions encompasses not only research project grants, (i.e., P01, R01, and R03) but all non-training mechanisms, as well. Specifically, funding in this area has increased by more than 65 percent (Table 5), with the number of research grants increasing by 47 percent (Table 6). The greatest increase in the number of grants was for the Small Grant mechanism (R03), with 80 percent going to new investigators. The number of R01 awards increased from 24 to 28, with FIRST awards (R29) and new investigator R01 grants remaining steady at between four and five.

Within the cognitive research domain, studies relevant to perceptual and/or motor development accounted for 32 percent of the research portfolio, with 18 percent addressing memory and 13 percent focusing on normative attentional processes. The remaining grants (37 percent) addressed topics related to children's thinking and learning, including the development of representations and concepts and higher order thinking skills. Interestingly, the majority of researchers funded in this area, 58 percent studied cognitive development during infancy, with most studies addressing perception and motor development. Only eight percent of the grants addressed early childhood, with five percent studying children during middle childhood and three percent addressing cognitive development during adolescence. Lastly, 21 percent of the grants focused on children across more than one age range, while two grants did not involve human subjects.

Social Development. Research relevant to social development comprised the second largest area of investment for the Program in Cognitive, Social, and Affective Development, representing approximately 44 percent of the total program portfolio. A significant concern, however, is that support for research in social development declined significantly in both expenditures (decline of more than 30 percent) and the number of funded applications (35 percent decline). Specifically, in 1995, the program supported 27 research grants in the social development area, totaling $5,928,454 (Tables 5-6). In contrast, in 1999, the program supported only 17 research grants for a total of $3,858,167. It is difficult to explain the declining trends in this critical area of development, but it is notable that the total number of applications addressing social development submitted for NIH review has also declined. This trend may be abating, however, as shown by the fact that the number of new investigators who received support for research in social development increased from 19 percent in 1995, to 29 percent in 1999.

Within the current portfolio devoted to social development, approximately 41 percent of the grants focus on social and academic competence and adjustment, while 35 percent address interpersonal relationships (e.g., parenting, peer relations, attachment), 12 percent examine social roles, and another 12 percent address self-concept/development and/or identity topics. In contrast to research focused on development during infancy in the cognitive area, the majority of grants in the social domain address development during adolescence (29 percent), with 12 percent focusing on development during infancy and middle childhood and six percent addressing social development during early childhood.

Finally, 41 percent of the grants address social development across age ranges.

Emotional Development. Research relevant to emotional development received the least support between 1995-1999, representing approximately eight percent of the program portfolio. This trend has remained steady since 1995, when the program supported five research project grants in the emotional development area, with four grants supported in 1999. Likewise, program investment remained stable, with $952,804 awarded for grants addressing emotional development in 1995 and $1,092,657 in 1999 (Table 5). Within the emotional development area, 80 percent of the grants funded between 1995 and 1999 were R01 awards, with the remaining 20 percent awarded via the Small Grant mechanism (R03). Of the four grants that received funding in 1999, two focus on the study of the development of aggression, one addresses the emotional correlates of self-esteem, and one examines the effects of marital conflict resolution on children's stress and coping. All of these research projects focus on multiple age groups, ranging from early childhood to adulthood, with each including a range of elementary school age children.

Research Training. Since 1995, the program has supported eight institutional training programs (T32) in child development and developmental psychology, which provided a total of 13 postdoctoral training slots, 38 predoctoral training slots, and two undergraduate research assistant slots, requiring a total investment of $4,442,391. Currently, three training programs emphasize cognitive development, two focus on perceptual development, two emphasize general developmental psychology, and one provides interdisciplinary training. Institutional training program trends have remained relatively stable over the past five years.

The program awarded nine individual post-doctoral fellowships (F32) over the last five years, requiring an investment of $462,416. In addition, the program supported supplements to 13 existing individual research projects to increase training opportunities for minority students at the high school, underdergraduate, graduate, and postdoctoral levels. This reflects a five-year total investment of $847,165.

STRATEGIC PLAN

The Program in Cognitive, Social, and Affective Development, in collaboration with members of the scientific community, developed strategic plans to address gaps in the current portfolio. In August 1999, in collaboration with other branches in the Institute, the program sponsored a conference entitled *Parenting and the Child's World* to address key issues related to the roles of parents in influencing child development. This national conference included scientists from different disciplines, who brought expertise from both basic and applied research settings. The proceedings and recommendations from this conference are currently being published as a book. An RFA was also designed to stimulate needed research in this area.

In October of 1999, CDBB sponsored a two-day workshop at the National Institute of Child Health and Human Development (NICHD) to identify research needs in the area of emotional development. Specifically, this workshop focused on the role of emotional signaling and

communication in emotional development and the need for more research on interpersonal aspects of emotion and emotional development. Recommendations from this meeting are currently being prepared, in addition to a research initiative that is being planned for the next few years.

Also in October 1999, the Branch co-sponsored an expert panel on youth violence intervention research to address key needs in this critical area. Results from this meeting were summarized in a report and are available from CDBB. In addition, recommendations made at this meeting were used to develop an RFA on youth violence intervention research, which was recently published.

Finally, during the past year the Branch sponsored several meetings focused on developing a valid and reliable definition/classification system for child abuse and neglect. These meetings brought together experts from the child abuse and learning disabilities fields to identify key issues in shaping a research agenda that can be used to formulate an empirically valid classification system. The results of these meetings are currently being used to plan the next phase of this activity, which will focus specifically on measurement and methodology issues related to classification.

Beginning in 2000, the Program in Cognitive, Social, and Affective Development initiated a formal strategic planning initiative, in collaboration with outside scientific leaders representing the developmental sciences. The specific purposes of this initiative were to develop a systematic process to 1) identify current research priorities and funding trends within the program; 2) identify gaps within the program's research and training portfolios; 3) identify scientific opportunities relevant to the development of theory, measurement models and analytic strategies, and models for translating and applying basic research findings; and 4) develop specific long-term plans and initiatives to address these issues. Initial reports summarizing this strategic planning process are currently available.

RESEARCH HIGHLIGHTS

Understanding how children develop cognitively, socially, and emotionally during childhood and adolescence is essential to fostering healthy child development. Likewise, a clear understanding of child development is critical to the design and implementation of prevention and early intervention programs to effectively ameliorate specific behavioral problems. Parents, educators, child-care providers, and others who work with children often require information about children's thinking, learning, and social and emotional development to create environments that are supportive of and optimize children's growth and potential. At the same time, such individuals contribute to the contexts of development that psychologists and other child-development specialists study in their efforts to describe and explain normative and non-normative developmental processes. Since 1995, the CDBB Program in Cognitive, Social, and Affective Development supported and extended research in normal child development, while also encouraging research that addresses specific risks to development, such as child abuse, poverty, and domestic and community violence. These research efforts have led to new knowledge related to children's abilities, as well as greater understanding of mechanisms of risk and protection in development. The remainder of this section reflects the research highlights of these advances.

Since the early 1950s, the role of exploration as an important driving force in infant behavior has been a focus of much research related to cognitive development. Only in recent years has this emphasis been applied to research on the development of perception and action systems, as a result of new approaches and methodologies available from related disciplines. Research supported by CDBB builds upon these emerging concepts and research methods to foster a new understanding of the dynamic structure of behavior and interactions with the environment and the complex interplay between perception and action systems. For example, early investigations applied dynamical systems theory to the development of motor behavior. Using this basic understanding of infant stepping behavior, subsequent research shows that complex motor behaviors emerge as the result of the dynamic interplay among numerous muscle and neural groups, over which the child gradually establishes control.

Other work is examining the emergence of laterality in young children's hand preference. By focusing on detailed examinations of emerging skills and applying a dynamic framework, CDBB grantees were able to explain infant behaviors in real-time and infant growth in developmental time. Early findings indicate that what looked like random behaviors are actually organized, but in nonlinear ways. The application of dynamical systems theory to motor behaviors also informed investigations examining the dynamic patterns in language acquisition and social interactions. This work is related to other CDBB-supported research that explores infants' understanding of their own motor activity. Specifically, one CDBB grantee is examining how children use feedback about motor activity to guide future motor activity. This research reveals that infants are aware of their own movements and actively respond to visual and kinesthetic cues to guide future movements.

Other CDBB-supported investigators have demonstrated that infants and young children have a complex understanding of the world around them, despite their apparent lack of sophisticated cognitive abilities. For example, one line of research is examining the development of visual expectations in young infants. This research program has produced a paradigm, the Visual Expectation Paradigm, that can be used to study expectations in infants as young as four weeks of age. In a related program, researchers are investigating how intuitive explanations and understandings related to notions of cause, mechanism, and agency emerge in development. An additional series of studies is examining infant comprehension of the physical objects in the world around them, by investigating their understanding of the behavior of visible objects (e.g., result of collisions, shadows), as well as their understanding of objects outside of their view (e.g., events occurring behind an opaque screen). These studies trace developmental changes from early infancy, where knowledge of visible objects is superior to knowledge of occluded events, to later infancy, when the knowledge structures become more equal.

Other cognition researchers are examining the development of representations and symbolic capacities in infants and young children. For example, CDBB-supported researchers found that, while young children may have complex understandings of the world around them, they may need explicit experience and instruction with symbols before they are able to show advanced representation skills. This finding has substantial implications for both instructional practices in educational settings, as well as the use of anatomical dolls in investigations of child abuse.

Increasingly, studies of cognitive development are examining development over longer time periods. One CDBB grantee is examining changes in infant visual information processing, specifically how these changes occur and the ramifications of the changes for how children at different ages interact with the world. Early studies found a developmental sequence in the types of visual information that are processed and utilized by infants. That is, at a young age infants process information regarding simple relationships, such as lines, but over time they begin to process information about more complex relationships, such as patterns within lines, to ultimately process the pattern as a meaningful unit itself. Such studies continue to shed light on the development of underlying, basic-level cognitive capabilities and serve to provide a rich picture of infant cognitive capabilities and their significance for later cognition.

Research funded by the Branch has also focused on the roles that parents, siblings, teachers, and peers play in children's self-concepts and social, emotional, and academic development. For example, one line of research has identified systematic, gender-typed patterns in children's attitudes, personal qualities, activities, and companions, as a function of fathers' attitudes about gender roles and gender of siblings. This research program also reported gender-typed patterns in parents' knowledge of their children, with mothers knowing more about daughters and fathers knowing more about sons. Interestingly, when mothers took on less traditional roles, working longer hours outside the home, the mothers maintained their level of knowledge of their children, while fathers became more knowledgeable about their children's activities and companions. Finally, results from this research have indicated that gender-typed family experiences have important implications for children's psychosocial well-being. For example, girls' grades in math and science declined between fifth and seventh grades when parents had traditional gender roles, but remained steady when their parents' roles were less traditional. Similarly, adolescent girls whose mothers expressed more traditional attitudes about gender roles reported higher levels of weight concerns, which is associated with higher levels of depressive affect and risky behavior and lower levels of self-worth.

Research examining developments in social, emotional, and moral understanding during the preschool and early school years indicates that some children as young as six can understand the possibility of having mixed emotions, while some four-year-olds can make distinctions between moral transgressions committed by friends and siblings as either victims or victimizers. Interestingly, early differences in understanding others' mental states in children younger than three predicts children's accounts of their later social experiences at school, their perceived self-competence at the start of kindergarten, and their observed interaction with friends. Similarly, differences in children's abilities to detect and explain the experience of mixed feelings early in life predict emotional understanding at the end of kindergarten, as well as social interaction patterns with siblings. CDBB-supported research also suggests that both mothers and siblings are important in moral development of children, although the relative influence depends on the age of the child. While maternal involvement appears to predict moral development during early childhood, as age increases, positive interaction with siblings appears to be more important.

Several studies supported during the past five years focused on understanding the factors that influence development among economically and ethnically diverse adolescents. Adolescence is a critical period for the development of behaviors and attitudes. However, little is known about

developmental changes in characteristics such as self-perceptions, interests, and values, in social, educational, and vocational goals, in involvement with either risky or positive activities, and in relations with family and peers. Research funded by CDBB is beginning to provide data on these important changes and on the factors that promote healthy adolescent adjustment. For example, as adolescents get older they are more likely to report suicidal ideation. However, as age increases, adolescents generally report feeling depressed and angry less often, although this trend interacts with race and ethnicity. Specifically, white females show an increase in depressive affect over time, with analyses suggesting that this is largely attributable to early maturation. Early maturing white girls are also at increased risk for eating disturbances and concerns about their future well-being. All other racial/ethnic groups show either a decrease in or stably low levels of depressive affect. This racial difference on the impact of early pubertal development on girls' mental health points to the importance of studying developmental phenomena across groups to understand the link of contexts to psychosocial development. Other findings from this research suggest that self-concept related to one's academic ability and positive valuing of school are related to increases in grade point average (GPA) and decreases in school problem behavior over time. In contrast, indicators of emotional distress predict declines in GPA and school engagement and increases in skipping school over time. These findings appear to be stronger for African-Americans than for whites. School experiences are also related to patterns of motivation and emotional distress, such that adolescents who report multiple risks (e.g., poor motivation to learn, high emotional distress, poor grades) also report a more consistently negative, developmentally inappropriate school environment. Similarly, other contexts, such as the family and peer group, appear to have strong influences on adolescent adjustment, with family processes continuing to exert a significant influence throughout adolescence and peer group exerting an increased influence over time.

Finally, recent research funded by the Branch is examining how specific risks, such as child abuse and violence, affect child development and how interventions to prevent violence may protect children from harmful outcomes. For example, CDBB currently funds several studies that examine intergenerational transmission of aggression and the impact of family violence and marital conflict on child development. Additionally, CDBB recently participated in the development of two RFAs, one on child neglect and one on youth violence intervention research, and a PA on career development awards for child abuse and neglect research. These initiatives seek to increase understanding of the antecedents, consequences, and mechanisms of child abuse and other violent behavior and to identify interventions to prevent or lessen the effects of violence on individual development. The Branch is also participating in a PA on the Science and Ecology of Early Development as part of a larger effort to increase research on the normative development of children in poverty. Finally, CDBB is leading a trans-NIH and trans-Federal agency initiative to develop reliable and valid definitions of child abuse and neglect. These efforts are expected to lead to new understanding of child cognitive, social, and affective development in ecological context and to new prevention and intervention efforts to promote optimal child development.

THE PROGRAM IN DEVELOPMENTAL PSYCHOBIOLOGY AND COGNITIVE NEUROSCIENCE

SCIENTIFIC MISSION

The Program in Developmental Psychobiology and Cognitive Neuroscience develops and supports research to study linkages among behavior, genetics, and the developing brain. Of particular interest are studies that contribute knowledge about growth patterns of brain and behavior to illuminate underlying normal and abnormal developmental processes at the molecular, genetic, cellular, and neural system levels. Research supported by this program over the past five years has contributed extensively to the understanding of how individual differences in neural and behavioral development presage developmental outcomes in sensory, motor, linguistic, and cognitive domains at different stages of development. The nature of these research endeavors is complex, requires collaborative approaches across disciplines and, many times, requires coordination across sites. Since 1997, this program has assumed an NIH-wide leadership role in the conception and design of research programs to acquire normative pediatric databases of brain structure and function from infancy through adolescence. This effort provides a much-needed foundation for interpreting data derived from neuroimaging studies of normally developing and impaired children with greater precision.

FUNDING TRENDS

Research Grants. Since 1995, the Program in Developmental Psychobiology and Cognitive Neuroscience has maintained a mean level of research grant funding of $5,693,015, ranging between $4,714,694 and $6,707,382 (Table 3, Psychobiological). The total amount of research grant funding between 1994 and 1999 was $28,465,077. The total funded research grants declined 20 percent from 25 in 1995, to 20 in 1999 (Table 4). From 1995-1999, the total number of funded research grants for this program was 119, and the level of research funding has remained stable. (Distribution of different grant mechanisms is shown in Tables 9-10.) The lack of growth can be explained as follows:

1. Three program project grants ended during this period, while only one new program project began in 1998. Funding of program projects totaled $1,188,545 in 1995, increased to $1,955,626 in 1996, and fell to $474,450 in 1996;

2. Investigator-initiated R01s generally maintained a yearly average of $4,523,285. R01 funding totaled $4,037,984 in 1995 and $4,177,231 in 1999, with little variation for the years in between. The total number of funded R01 grants declined 22 percent from 1995 (total = 23) to 1999 (total = 18);

3. The program funded one Small Grant (R03) and one Small Business Grant (SBIR; R43) in 1999; it also funded one Shannon Award (R55) in 1998; and

4. Other research awards, such as funding for conferences (R13), Educational Projects (R25), and Merit Awards (R37) showed a modest 14 percent total increase between 1995 ($691,854) and 1999 ($795,157), with no increase in the total number of awards (six to seven total awards for each year from 1995-1999).

During the last five years, the majority of grants funded through this program have been non-competing renewals (54 percent). The next-largest proportion of funded research grants were new awards (23 percent), followed by competing renewals (13 percent). Supplements and extensions during this period were each less than ten percent of the total awarded grants.

Developmental Behavioral Neurobiology. This area of the program has received the highest levels of funding over the last five years, representing 39 percent of the program awards. Funding in this category remained fairly stable at $2-$3 million in research support between 1995 and 1999. The number of research grants fell 25 percent between 1994, when 20 grants for developmental neurobiological research were funded, and 1999, when only 15 grants were funded. Strategic planning for the next decade will focus on activities to stimulate research within this category (see Strategic Plan, below).

Behavioral Genetics. This represents the second-highest funded scientific area of the program, with 30 percent of overall program funding. Funding levels were maintained at approximately $2 million over the last five years. The number of grants in this category was between seven and eight over the last four years.

Developmental Behavioral Endocrinology. Funding levels for research in this scientific area were maintained at 23 percent of the program portfolio. There was no appreciable decline in level of funding, but the number of grants increased from seven in 1995 to ten in 1999.

Developmental Neuroimaging. Although this area of the Program in Developmental Psychobiology and Cognitive Neuroscience represents only four percent of program funding since 1994, its level of funding has doubled over the past five years. An exciting new initiative is the structural magnetic resonance imaging (MRI) normative database contract, which involves seven sites and a data coordinating center. The NICHD provides equal support of the contract with the National Institute of Mental Health (NIMH) and the National Institute of Neurological Diseases and Stroke (NINDS). The project will yield a unique and valuable database of normative brain growth and brain-behavior correlates, from birth through 18 years of age. This database will be made available to researchers and clinicians in the pediatric neuroimaging field. In fall of 1999, the NICHD was the lead sponsor of a conference on pediatric functional neuroimaging, with NIMH and NINDS. The conference addressed the feasibility of various types of functional neuroimaging modalities with children, the need for standardization of imaging protocols, and the complexity of developmental research addressing brain-behavior associations. The conference also stimulated multidisciplinary collaborations among the leaders in the field. CDBB anticipates that this research area will continue to grow significantly over the next five years (see Strategic Plan section, below).

Fetal Behavioral Neurobiology. This area of research also represents four percent of the program funding. However, this area continues to be of significant scientific interest (see Strategic Plan section, below). Funding, although limited, has increased over the last five years.

Research Training. The Program in Developmental Psychobiology and Cognitive Neuroscience consistently supported between eight and 12 research training grants over the last five years. Approximately ten percent of the program's total allocated funds are applied to research training grants, when compared to other types of grants. During the past five years, the program supported four institutional training programs (T32), with two in developmental behavioral neurobiology, one in behavioral genetics, and one in developmental psychobiology. The total program investment was $2,268,230 for 1995-1999.

Ten post-doctoral fellowships (nine F32s and one F33) were awarded since 1995, equaling an investment of $1,163,562. In addition, the program supported supplements to nine existing individual research projects to increase training opportunities for minority students at the high school, underdergraduate, graduate, and postdoctoral levels. This reflects a five-year total investment of $243,122.

STRATEGIC PLAN

In the summer of 1999, a committee of prominent scientists from various fields, including pediatrics, neurology, psychobiology, neuropsychology, developmental psychology, and developmental biology convened to develop a framework for strategic planning in the area of developmental biobehavioral research for the NICHD. Although this process was pertinent for several NICHD branches and programs, specific topics from the framework are directly relevant for the Program in Developmental Psychobiology and Cognitive Neuroscience. Specific topics considered for increased attention within the strategic plan include the following:

- ***Influences of Sex/Gender throughout the Developmental Process.*** Major gaps exist in the understanding of this aspect of human development. To close these gaps, it is important to stimulate research that clarifies the interaction of biological factors (e.g., neurobiological and physiological) with environmental and social influences and examines how different mechanisms lead to differential outcomes between the genders in terms of cognitive, social, and emotional development.

- ***Fetal Neurobehavioral Development.*** At present, little is known about 1) what fetal behaviors and their interactions with biological and environmental factors tell us about the developing fetus/neonate; and 2) how such behavior is related to physical and neurological status and perinatal outcome. Research in this area has the potential to provide major advances in understanding human biobehavioral developmental processes and critical early developmental periods.

- ***Adolescence.*** Despite the many important neurobiological, hormonal, and social behavior interactions to be addressed during transitions into, from, and throughout this developmental period, little comprehensive research exists on adolescence. Research is needed for understanding normal adolescent development, to not only increase the understanding of biobehavioral development during this period, but also to inform research investigating the specific mental health, behavioral, and emotional vulnerabilities of the adolescent.

- ***Developmental Neurobiology Underlying the Emergence of Prosocial Behaviors vs. Violent and Aggressive Social Behaviors.*** Several bodies of animal-model and human evidence underscore the important roles that hormones, neurotransmitters, neuroendocrines, neurocircuitry, and neuroreceptors play in the development of complex social behaviors, including the formation of social affiliations, parental care, and social aggression. More research is needed, however, to learn about how biological factors, interacting with brain development, cognition, and environmental and situational influences, result in prosocial, empathetic behaviors or, alternatively, in social aggression and violent behaviors, particularly over time. Understanding these interactions will aid in the ability to predict and prevent human violence, while facilitating the ability to construct effective interventions for preventing human aggression and violence.

- ***Interaction of Neuroendocrine and Environmental Influences.*** Because the endocrine system plays an important role in stimulating neurobiological activity, it is important to better understand the interaction of neuroendocrine and environmental factors on development and behavior, particularly in response to internal and external stressors.

- ***Neuroplasticity and Learning.*** Hormones can have pronounced effects on dendritic spine shape and motility, potentially affecting the efficiency of associative learning networks. Research is needed to better understand how these events occur and influence outcomes throughout development. In addition, recent studies demonstrate that neurons within the temporal lobe may regenerate, opening several important avenues of research on human learning, memory, and other aspects of development.

- ***Methods.*** The strategic plan framework highlights two methodologies that are relevant for the Program in Developmental Psychobiology and Cognitive Neuroscience: animal models and techniques for establishing brain-behavior correlations. The plan emphasizes the strong need for animal models to explain the more fundamental, mechanistic aspects of the research areas. Specifically, emphasis should be placed on developing parallel behavioral models between animal models, such as mice or monkey models, and humans.

The strategic plan also points out that it is impossible to conduct functional neuroimaging studies for investigating brain-behavior correlations without specifying functional tasks to be studied. Functional genomic and functional imaging research require accurate analyses of the phenotype and the development of age-specific activation tasks likely to target specific brain areas involved in emotional and cognitive functioning. Thus, the development of age-specific model tasks is also emphasized. Priority remains on work that uses multiple techniques on the same subjects,

including co-registration of subjects involved in both functional magnetic resonance imaging (fMRI) and event-related potential (ERP) procedures. The fMRI technique yields more information about spatial resolution, while ERP yields good temporal information. When combined, data from both techniques tell a more interesting story and provide complementary information that enhances research insights.

RESEARCH HIGHLIGHTS

A major challenge facing the biomedical sciences is to understand how genetic and environmental factors act on the brain to regulate the development of behavior and how behavior can, in turn, modify brain development. Major research findings supported by the Program for Developmental Psychobiology and Cognitive Neuroscience are advancing knowledge in this complex area. Research topics in this program generally fall into one of the following conceptual categories.

Developmental Behavioral Endocrinology. The aims of the funded research within this scientific category vary. Some of the work studies the structural plasticity of the brain and how endocrine-mediated behavioral development affects brain processes, such as memory, attention, affect, social cognition, and other higher-order cognitive functions. For example, CDBB-supported researchers are investigating gonadal hormone influences on human cognitive and social behavior. This longitudinal work builds on a natural experiment involving infant females who are exposed to excess androgens beginning early in gestation as a result of congenital adrenal hyperplasia (CAH). As CAH girls mature into adolescence, they show significantly higher interest in "male-typical" activities (e.g., playing sports, building models) and career interests (e.g., engineering) than control girls. They also show significantly lower "female-typical" activities (e.g., playing with dolls or makeup). CAH girls also score higher than control females on cognitive spatial ability tests, which is similar in increased ability to males, and demonstrate increased aggression. Overall, this work indicates that the level of androgen present early in development continues to exert significant influence on gender-typed activities and interests, as well as cognitive functioning into adolescence. This research also shows that social factors can modify the expression of these hormonal influences (i.e., same-sex choice of playmate and best friend).

Other Branch-supported research investigates environmental and physiological factors underlying behaviors such as pair bonding, aggression, responses to stress, or the nurturing of offspring. For the last several years, researchers at the University of Maryland have been working with prairie voles to analyze the behavioral and physiological factors underlying pair bonding, the development of mammalian social behavior and aggression, and the behavioral effects of hormonal stress reactions. This work indicates that both oxytocin (OT) and arginine vasopressin (AVP) have strong effects in inducing partner preferences for both male and female prairie voles, which are monogamous. Results demonstrate that both sexes use both peptides to facilitate bonding, but AVP is more physiologically important in males. Females, in contrast, are more likely to both produce and respond to OT. Of significance is the additional finding that peripherally administered OT is capable of facilitating pair bonding in females, but not in male prairie voles. Similarly, peripheral AVP does not facilitate pair bonding in either males or females.

Both stress and adrenal hormones, which are regulated through the hypothalamic-pituitary-adrenal (HPA) axis in the brain, also have sexually dimorphic effects on behavior. Studies indicate that heightened HPA axis activity (occurring during stress) facilitates initial pair bonding in young male prairie voles, but inhibits the formation of pair bonds in young female voles. However, OT, released during birth, lactation, or familiar social contact, inhibits HPA axis activity and appears to facilitate social attachment. These results are significant in that the capacity of OT to inhibit the HPA axis may be important in the formation of human attachments and in explaining the capacity of social behavior and social bonds to regulate human stress responses. During 1999, the NICHD awarded a program project grant for continuation and expansion of this work to investigate the biological mechanisms that regulate social bonding, aggression, and behavioral stress responses.

The HPA axis is also the focus of research at the University of Minnesota, where for 18 years NICHD-funded researchers have been studying the development of the HPA axis stress response and its relation with stress-reactive temperament in young children and children's health. The study of the HPA axis stress response is particularly important to study developmentally in humans because of the strong evidence in animal models for long-lasting HPA effects, even when stressors are eliminated or reduced. Recent work focuses on three-to-eight year old children. Results indicate a significant impact of context (home vs. out-of-home) on HPA activity (measured via salivary cortisol samples) and its relation to temperament. The data suggest that for the shy and inhibited child, there is suppression in adrenocortical functioning when the child is away from home and/or family. For the shy child in a social setting, when it would be expected that cortisol would be higher than at home, there is a suppression that dissociates adrenal activity from shy/anxious reactions in young children. This suppression in adrenocortical functioning appears to be a phenomenon of childhood, since it is not seen in adults. The timing of the developmental change is currently under investigation, as is whether or not the young child's HPA response to frustration/anger is also moderated by the quality of the child-parent relationship. Current work continues to support the hypotheses that children's personalities and social behavior relate to their neuroendocrine stress reactivity and that this relationship is moderated by environmental context and influence.

Developmental Behavioral Neurobiology. A number of CDBB-supported researchers are investigating the brain from the synaptic level to the structural. One major goal of this research is to explain brain-behavior relationships and to provide evidence for developmental cortical plasticity. For example, researchers at the University of Maryland are developing and studying a model of experience-expectant cortical plasticity that examines electroencephalograph (EEG) coherence in infants with different levels of crawling experience. Recording resting EEG from frontal, parietal, and occipital sites of both hemispheres, researchers found greater EEG coherence between intrahemispheric sites in novice crawlers (1-4 weeks) as compared to prelocomotor infants and experienced crawlers. These data suggest that the anticipation and onset of locomotion are related to an overproduction of cortico-cortical connections. Pruning of these overabundant connections may be a source of decreased coherence, as crawling becomes more routine. The research team also found that the pattern of frontal activation, as measured by the ongoing EEG, may be a marker for individual differences in infant and adult disposition in responding with either positive or negative affect. Children who display social competence (e.g., high degree of social initiations and positive affect) exhibit greater relative left-frontal activation,

while children who display social withdrawal (e.g., isolated, on-looking, and unoccupied behavior) during play sessions exhibit greater relative right-frontal activation. These EEG/behavior findings suggest that resting frontal asymmetry may be a marker for certain temperamental dispositions.

Ongoing CDBB-supported research examines neuronal plasticity and behavioral effects in the neonatal rodent brain in response to early pain experiences. This research, motivated by clinical work with preterm infants in neonatal intensive care, suggests that repetitive painful experiences or prolonged exposure to analgesic drugs during the neonatal period can permanently alter neuronal and synaptic organization in the somatosensory cortex. Somatosensory differences in neonate rodents with early exposure to noxious stimuli which, compared to neonates exposed to non-noxious stimuli, were associated with adulthood increased fos activity in the somatosensory cortex, when exposed to pain, hypersensitivity to pain, weight gain, increased preference for alcohol, more restricted exploratory behavior, and increased social withdrawal behaviors. Increased plasticity of the neonatal brain may allow these and other changes in brain development to increase later vulnerability to stress disorders and anxiety-mediated adult behavior.

Developmental Behavioral Genetics. The area of developmental behavioral genetics draws upon a variety of techniques and designs to explore the relations among genes, environment, and behavior throughout development. An example of such research is the Colorado Adoption Project, supported through CDBB for over 20 years. The primary objective of the project is to assess genetic and environmental influences on individual differences in behavioral development. In recent analyses, researchers investigated ratings of temperament in middle childhood as part of a sibling adoption design analysis. Significant genetic influence emerges for ratings of activity, sociability, and emotionality. Evidence of shared family environment is nonsignificant in all areas except for ratings of attention span.

Using a very different behavior-genetics paradigm, researchers at Cold Spring Harbor Laboratory are undertaking genetic analyses of learning and memory in the fruitfly, *Drosophila melanogaster*. Emerging findings support two main themes. First, discovery and manipulation of genes involved with behavioral development in genetically accessible systems, such as *D. melanogaster*, enables dissection of the biochemical, cellular, anatomical, and behavioral pathways of learning and memory. Second, because core cellular mechanisms for simple forms of learning are evolutionarily conserved, biological pathways discovered in invertebrates are likely to be conserved in vertebrate systems as well. Recently, researchers reported that mutations in the latheo (LAT) gene disrupt associative learning in Drosophila and that LAT is a novel presynaptic protein with a role in the calcium ion-dependent synaptic modulation mechanisms that are necessary for behavioral development.

Fetal Behavioral Neurodevelopment. Studies in this area of research address the interaction between environmental and neurobiological influences on fetal behavior and the correlation of fetal behavior with neonatal outcome. For example, researchers at Northeastern University are investigating the development of circadian regulation in the mammalian fetus. According to recent comparative studies, melatonin is the mammalian fetus' window to periodicity of the outside world. A function of melatonin during development is to entrain the developing circadian

pacemaker (e.g., the organism's ability to regulate sleep/awake cycles and other biological rhythms) within the suprachiasmatic nucleus of the brain. The broader distribution and greater abundance of melatonin receptors during development, relative to mature animals, suggest that the developmental effects of melatonin are greater and more diverse than those shown during adulthood. An implication of this research is that the situation warrants caution, not only concerning the use of exogenous melatonin during human pregnancy and lactation, but also concerning behavior that might disrupt the mother's endogenous melatonin rhythm.

THE PROGRAM IN BEHAVIORAL PEDIATRICS AND HEALTH PROMOTION

SCIENTIFIC MISSION

The CDBB Program in Behavioral Pediatrics and Health Promotion examines the critical role of behavior in relation to health, growth, and development, from conception through early adulthood. A major focus of this program is on the conceptualization, initiation, and support of research programs to identify the basic biobehavioral mechanisms involved in health risk-taking behaviors and the prevention of risk-behaviors at all stages of development. During the past five years, the program developed and supported initiatives addressing the prevention of childhood and adolescent injuries, eating disorders, tobacco use in childhood and adolescence, childhood and teenage suicide, and risk behaviors related to unprotected sex. Moreover, this program plays a significant role in developing and supporting research to identify the conditions under which children with both acute and chronic illnesses adhere to medical and behavioral treatment regimens.

FUNDING TRENDS

Research Grants. Since 1995, the Program in Behavioral Pediatrics and Health Promotion has funded a total of 96 research grants, for a total of $37,444,331. Funding increased approximately 163 percent, from $4,219,094 in 1995, to $11,111,127 in 1999 (Table 3, Health). The number of research grants also increased, from 12 awards in 1995, to 32 in 1999 (Table 4). During the past five years, the majority of awards utilized the R01 mechanism (68 percent). Of the total expenditures for research grants for this period, R01s received 88 percent of total funding. R03s received approximately one percent of funds. (Distribution of funds and numbers of grants by mechanism are shown in Tables 11-12.) For analytical purposes, this program's areas of interest are subdivided into four categories: health promotion/disease prevention/risk behaviors; injury prevention; adherence/consent; and pain, stress, illness/babies born at risk.

Health Promotion, Disease Prevention, and Risk Behaviors. From 1995-1999, research in health promotion, disease prevention, and risk behaviors accounted for the greatest number of awards (49), representing approximately 37 percent of the total number of awards, and the second-highest cost ($13,023,546). The number of awards in

this area increased steadily, from four in 1995, to 15 in 1999. Of the total awards granted, 17 were in the health education and screening area, 12 were for tobacco-related research involving prenatal effects, pharmacological and behavioral treatment, prevention of initiation, and nicotine abstinence; six were made to researchers investigating attention deficit hyperactivity disorder (ADHD) or other attentional problems; and six were made to HIV-related research projects, specifically for prevention education. Only five of the awards supported research in the risk behavior field, while three awards were for research in physical activity and health.

Risk behavior research includes studies of risk perception biases and risk for eating and body image problems. Research investigating antecedents and prevention strategies for risk behaviors, including early sexual behavior, antisocial behavior and suicide, is both important and timely. Researchers recommend extending the research on precursors of risk behavior to include the middle childhood years. Studies of motivational factors, including religion and the religious community, as they relate to the development of risk behaviors, are of great interest to this program but are not currently funded. In 1999 an RFA, *The Prevention of Health Risk Behaviors in Middle Childhood,* was published to stimulate research efforts in the identification of risk and resilience factors associated with precursors of risky sexual behavior in middle childhood. The goal of the RFA is the prevention of pregnancy and sexually transmitted diseases, including AIDS. This RFA directs researchers into an area where little is known about the interactions of innate cognitive, developmental, and psychological characteristics in children ages six-to-12 years. These unknown interactions, in conjunction with known sociocultural and economic conditions, facilitate and predispose children to participate in high-risk sexual behaviors.

Three awards granted since 1995 focus on physical activity in children. With ever-increasing rates of overweight and obese children, unhealthy lifestyles, excessive TV viewing, partial sleep deprivation in adolescents, and inadequate physical exercise, additional research is needed to explore ways to counteract these trends. Similarly, research is needed to better understand the links between body image, obesity, and eating disorders.

Injury Prevention. Between 1995 and 1999, the Program in Behavioral Pediatrics and Health Promotion made 10.6 percent of its awards, totaling $3,946,516, to researchers studying injury prevention. The majority of awards in this category were R01s. The number of awards decreased from three in 1995, to two in 1999. Despite an increase in funding from 1995-1999, the percentage of funds invested in the injury prevention arena declined from 13.6 percent in 1995, to six percent in 1999.

The Branch funded epidemiologic, ethnographic, descriptive, and preventive studies in injury research. In light of the significant morbidity and mortality related to injuries, the leading killer of children from ages 1-19, the decline in research in this critical area reflects a gap that must be addressed. To this end, the program is collaborating on a trans-agency initiative dealing with emergency medical services for children. NICHD areas of interest

include the following: childhood injuries, including the surveillance of injuries, their mechanisms, risk factors, etiologies, environmental influences, interventions, and preventions; the care of suicidal children and adolescents; the outcomes of emergency care for children with acute illness secondary to trauma, infection, or acute exacerbation of chronic illness; the biobehavioral aspects of pain, stress, and coping with illness or injury in situations of emergency care; behavioral factors involved in risk-taking behaviors with subsequent need for emergency medical services.

Adherence/Consent. Despite the absence of awards in this area in 1995-1996, the Branch has awarded 11 grants since 1997. A total of $1,496,466 (3.7 percent of the five-year program expenses) went to the 11 awards. The funding nearly tripled during the last three years, increasing from $250,205 (3.8 percent of the yearly research funds) in 1997, to $710,025 (7.2 percent of the yearly research funds) in 1999. Despite sophisticated antibiotics and cognitive behavioral therapy, medical conditions persist because of problems associated with adherence. Unfinished courses of prescription medications, shortened courses of physical therapy, and missed glucometer readings and peak flow measurements are examples of adherence problems that can potentially result in suboptimal outcomes. Research on adherence and consent received 9.5 percent of the total awards for the Program in Behavioral Pediatrics and Health Promotion over the last five years. The potential for improved health with scientific advances in this field makes additional studies desirable. The program is participating in the 1999 RFA entitled *Testing Interventions to Improve Adherence to Pharmacological Treatment Regimens*, which will be instrumental in developing interventions to improve adherence. Intervention and translational research are emphasized in this RFA.

Pain, Stress, Illness/Infants Born at Risk. This program interest area received funding for 42 awards over the 1995-1999 period. Of that, the $2,960,844 spent in 1995 increased by 56 percent to $4,618,455 in 1999. Some studies supported include research on illness behavior and somatization in children, infant pain and colic, effects of illness on development, therapeutic interventions for chronic medical conditions such as constipation, and developmental outcomes of premature infants. The Branch is participating in the PA entitled *Biobehavioral Research for Effective Sleep*. Acute and chronic partial sleep deprivation in children is associated with decreased cognitive functioning and school performance. Sleep deprivation may also be a risk factor for poor behavioral adjustment and behavioral problems, such as ADHD. The potential consequences of sleep deprivation on behavior and growth across different stages of development is of interest to this program, but has not been well characterized.

Research Training. Since 1995, the program funded two institutional training grants, supporting a total of five postdoctoral and three pre-doctoral trainees. The total cost for these programs was $305,822 (Table 11). One of the institutional training programs provides post-doctoral training in pediatric psychology research, in collaboration with pediatrics and behavioral pediatrics. The second training program focuses on health behavior research in minority children with chronic diseases.

In addition, the program funded one midcareer investigator award in patient-oriented research (K24), for a total cost of $90,771. This award provides support for a clinician to conduct research and mentor new investigators. The investigator is examining the influence of acculturation and community factors on child health outcomes in Latino children.

From 1995-1999, $474,773 in total funds were awarded for training, including institutional training grants (T32) and the midcareer investigator award (K24), within the Program in Behavioral Pediatrics and Health Promotion. Based on the number, type, and focus of research training awards in this program, a need exists for additional research training in several areas:

1. Postdoctoral research training programs for physicians and psychologists in research methodology, as well as basic and applied research, especially in areas of injury prevention and risk behaviors;

2. Minority fellowships and career awards to investigate health disparities, causes, consequences, and access to care; and

3. Training opportunities for career investigators in various phases of their careers in the following areas: injury prevention; health promotion, including the identification of childhood precursors of risk behaviors; eating and sleep disorders; interactions of health and behavior leading to academic failure, youth suicide, homicide, and antisocial behavior; and the effects of pain, stress, and illness on children and their families.

Currently the Program in Behavioral Pediatrics and Health Promotion promotes the career award (e.g., K08, K23, K24) as a mechanism to encourage research in understudied areas of interest, notably injury prevention, chronic illness, health disparities, and adherence to medical and therapeutic regimens. Even though the program funded only one K24 award from 1995-1999, the program currently has five K24 awards funded or with funding pending in FY 2000.

Supplements represent an additional means of securing funds for existing studies to expand the scope or increase the size of an existing program. Supplemental funds were awarded to one of the currently funded institutional training programs in 1999, to increase the number of available postdoctoral fellowships. Minority supplements are also encouraged as a means of providing research experience and chances for collaborative efforts with established researchers.

STRATEGIC PLAN

The Program in Behavioral Pediatrics and Health Promotion will initiate its five-year strategic planning process in 2001. This initiative will develop a systematic process to 1) identify current research priorities and funding trends within the program; 2) identify gaps within the program's portfolio of research and training awards; 3) identify scientific opportunities pertinent to surveillance and measurement models, analytic strategies, and translational methods; 4) establish future scientific priorities based on current needs assessment and advice from the research community; and 5) develop specific, long-term plans and initiatives to address these issues.

One emphasis within the program is research on injury prevention and the identification of precursors of health risk behaviors in middle and early childhood. New efforts are evolving to stimulate research in injury prevention and health risk behaviors in childhood, but the need is great and far outweighs the percentage of programs currently funded. Promoting interventions for injuries and behavioral or developmental problems is important and must incorporate the external forces that affect biological and behavioral functioning.

Understanding the behavioral issues associated with injury, illness, growth, obesity, eating disorders, risk behaviors, and health promotion within the developmental context will be a high priority for this program. The knowledge will complement research on biological diseases, precursors of adult diseases with origin in childhood, and injury mechanisms. The biobehavioral approach taken by this program aims to encourage research and collaboration of researchers to study the biological, behavioral, and environmental factors preceding, maintaining, aggravating, alleviating, or interacting with processes of health, illness, or injury.

Identifying the uniqueness of children (i.e., their development, behavior, and cognitive abilities) and allowing research to inform the clinical community as to the appropriate provisions of age-specific, gender-specific, and culturally sensitive treatment for children of all ages are two notable goals of this program. Promoting research to identify scientifically sound health care recommendations, based on an understanding of the biological and developmental processes, which dictate well being and promote growth in infants, children, and adolescents is another goal for this program.

One final and crosscutting issue that relates to all areas of program interest is understanding motivation. Behavioral research, with its recording of statistics and events, deciphering causes, recognizing subsequent effects, developing preventive strategies, and devising interventions, is not sufficient to remedy the behaviorally based problems facing the current generation of children. Understanding the interaction of genetic, learned, and environmental influences that affect an individual's choice to act or refrain from some action (e.g., sexual risk taking, overeating, quitting school, viewing television, antisocial behavior) is crucial to promoting change. Examining the influence of specific communities (e.g., religious, family, academic) on motivation is likewise an area of intense interest.

RESEARCH HIGHLIGHTS

The Program in Behavioral Pediatrics and Health Promotion funds research involving a variety of different chronic and acute pediatric medical conditions. Highlights for a few of these conditions, as they address the themes of medical adherence, childhood injury, parenting, and effects on child development, appear below.

Asthma and Medical Adherence. Asthma is an increasingly common pediatric problem. According to national statistics, the morbidity and mortality related to asthma has increased at an alarming rate over the past two decades (Weitzman et al., 1992). Despite the current

pharmacologic armamentarium to control chronic asthma in children, for many individuals the condition remains poorly controlled and results in significant morbidity and financial expense. Having effective medical and pharmacological interventions does not necessarily presage improved health; nonadherence to medical management regimens increases morbidity. Thus, research on chronic childhood illness is expanding to investigate children's understanding of illness, the roles of both parents and children in prevention, management of symptoms, and children's adherence to medical regimens.

CDBB-supported researchers at Brown University are studying children's adherence to inhaled asthma medication during their transition to adolescence. To date, the results indicate that older children and teenagers are typically less adherent to medication regimens and that an alarming number of parents and children lack basic knowledge of asthma drugs. However, developmental and social maturation play a central role in children's assuming responsibility for their own asthma management. The findings have significant clinical implications: for young children, effective medical management of chronic diseases requires a high degree of parental supervision; and, health care providers should not assume that families have a clear understanding of medical treatment or prevention, even after several sessions with the medical provider. Determining the child's and parents' levels of understanding of the medication, the indications for drug usage, the simplistic mechanism of drug action, and the assignment of roles related to the medical management task may increase medical adherence and reduce associated morbidity.

Childhood Injury. Previously, injury and disease rates among racial/ethnic groups were derived from comparisons between individuals of African American and Euro-American origins. More recently, as the Hispanic/Latino population has become the largest minority group in the United States, additional ethnographic data are being collected from this important population. Considerable diversity exists in terms of health indicators, diseases, and injuries within the Hispanic population, apparent both by country of origin and area of residence in the United States. To develop a better understanding of this diversity, a CDBB-supported research team at the University of Southern California is examining differential risk and cause of injury among recent immigrant Mexican, acculturated Mexican-American, and non-Hispanic white children. By merging ethnographic and epidemiologic research designs and methods of data collection and analysis, the investigators can enhance understanding of the underlying factors in childhood injuries in these populations. Pilot data on Mexican-American mothers of preschoolers provide insights into the injury risks and prevention practices in this population (e.g., low acculturation, extreme poverty, and severe household crowding). Among the significant results to date, the team found that a paucity of safety measures, numerous observable hazards, and minimal active maternal supervision are noted in the home environment of Mexican-American mothers. In addition, children as young as six years of age served as child nurses or babysitters. Although all the mothers in the pilot study understood that certain environments/objects posed a risk of injury to their children, many of the mothers did not take appropriate action to reduce the potential risks. These findings are critical to the development of problem-specific risk intervention programs and for the development of injury specific instructional methods and materials.

Parenting. In recent years, increased numbers of employed mothers and decreased extended family support have contributed to the stress placed upon mothers. Early interventions designed

to enhance maternal understanding of infant development also function to reduce the stress of parenting and improve infants' social, emotional, and cognitive development. One CDBB-supported SBIR grant aimed to improve parent attitudes and feelings of self-worth by increasing their knowledge and awareness of their infants' abilities, unique adaptive capacities, and communication cues. In this project, researchers developed and tested the efficacy of an eight-hour, multi-media course on infant development, which spanned the first year of life. The program was designed to teach parents how to observe and respond to their infant's needs at each stage of development through the first year of life. The documentary-style videotapes depict babies and their parents interacting, first when the babies were newborns, and then every other month, beginning with the first month of life and ending at 12 months. Interactive dialogue between parents and various infant development experts on the videotapes provide an opportunity for parallel learning for the parents in the study.

Intervention participants showed a significant increase in knowledge of newborn development, when compared to participants in a control and a comparison group. Mothers who viewed the video series were more likely to schedule their infants' routine examinations in a timely manner. Behavioral effects were determined by examining first-year infants' pediatric health care/illness variables. For the group of infants whose mothers participated in the video series, fewer medicines were prescribed per infant, fewer diagnostic tests were ordered, fewer referrals to specialists, hospitals, and ERs were made, and fewer severe illnesses occurred throughout the year. Two high-risk subsamples (young/teen mothers and mothers of pre-term infants) were also included in the study. Mothers who participated in the video series gained in both knowledge and maternal confidence when compared to the control group.

Much can be learned by more extensive testing of health outcomes in the high-risk subgroups. Examination of injury rates, both intentional and unintentional, might give additional insight into the relationship between maternal knowledge of infant and early child development and subsequent injury rates. Likewise, correlating maternal knowledge of infant behavior with parenting skills and health outcomes is an attractive area for future investigation.

Otitis Media and Child Development. Second only to the common cold, ear infection (otitis media; OM) is the most commonly diagnosed and perhaps most prevalent illness among children in the United States. Numerous factors may increase children's risk of developing otitis media, which has a propensity to recur and to become chronic. In ten to 25 percent of cases, persistent fluid remains in the middle ear space for three months or longer. Understanding the epidemiology of ear infections is a practical tool for the health care practitioner.

Within this context, CDBB-supported researchers at the University of Pittsburgh are investigating the possible causal relationship of otitis media with effusion (fluid in the middle ear) in the first three years of life and with lasting impairments of speech, language, cognition, or psychosocial development. To date, this research has led to a number of findings. Middle ear effusion (MEE) is very common in children before the second birthday, usually greatest in urban infants and least in suburban infants. Sociodemographic risk factors include low socioeconomic status (SES) and repeated exposure to large numbers of other children. Clinically, irritability is not an accurate diagnostic symptom specifically for otitis media. Tympanometry has a very high negative

predictive value and sophisticated hearing tests confirm the relationship between effusion status and hearing levels. Parent-child stress and children's behavior problems in the first three years of life show little or no relationship to prior duration of MEE. Likewise, early-life otitis media does not affect developmental outcomes adversely. Early placement of tympanostomy tubes to drain middle ear fluid does not have a beneficial impact on developmental outcomes.

THE PROGRAM IN HUMAN LEARNING AND LEARNING DISABILITIES

SCIENTIFIC MISSION

The CDBB Program in Human Learning and Learning Disabilities develops and supports research initiatives to increase knowledge relevant to normal and atypical development of reading, written language, and mathematics abilities throughout the life span. Likewise, this program emphasizes the development of prevention, early intervention, remediation, and classroom instructional approaches and methods to ensure robust acquisition of reading, written language, and mathematics skills at different stages of development. A hallmark of this research program is the conceptualization and initiation of sustained systematic longitudinal programs of research that employ multiple scientific disciplines working in collaboration. The program applies a wide range of behavioral and biological research methods and modalities to identify how children learn to read, why some children do not learn to read, and to develop prevention and intervention approaches that can ameliorate reading disabilities. This program continues to build the NICHD Reading Research Network, composed of 42 sites nationally and internationally, the largest reading research program in the world (see Appendix E). During the past two years, the program has focused on creating new programmatic research initiatives in both written language development and mathematics.

FUNDING TRENDS

Since 1995, the Program in Human Learning and Learning Disabilities has grown in terms of both research funding and the total number of grants supported (see Tables 1 and 2). Total funding increased 70 percent, from $11,091,527 in 1995, to $18,805,584 in 1999. Likewise, the total number of grants increased from 27 in 1995 to 33 in 1999, reflecting a 22 percent increase. Total funding for the past five years was $80,090,476. Trends in funding by type of research mechanism have also changed substantially during the past five years (Table 13). In 1995, funding for both Research Centers ($2,828,792) and Program Project grants ($5,097,538) exceeded funding for R01 grants ($2,723,492). CDBB expected this situation, given that this program initially developed through NICHD-initiated efforts, rather than investigator-initiated applications. In 1999, funding for R01 awards ($8,011,138) exceeded support for P50 applications ($5,777,248) and P01 awards ($3,698,822) (Table 13). This phenomenon reflects a substantial increase in R01 funding and in the number of R01 grants awarded. These trends are highly encouraging and clearly indicate that the research program, initially developed by program-

guided initiatives, is now flourishing because of interest from the scientific community. Thus, both the Center (P50) and Program Project (P01) mechanisms worked as designed, to provide a strong scientific foundation that can be extended over time through the work of individual investigators. Likewise, funding for new investigators through the Small Grant mechanism (R03) is increasing, as is support for SBIR grants (see Tables 13 and 14).

STRATEGIC PLAN

During the past five years, the CDBB Program in Human Learning and Learning Disabilities, in collaboration with the scientific community, has developed strategic plans to extend the current research in reading development, reading disorders, and reading instruction and to develop and support new research and research programs in mathematics development and mathematics cognition.

In May, 1997 a literacy research strategic planning meeting was convened to 1) assess the current state of research knowledge in reading and writing development; 2) identify gaps in the extant research base and identify immediate scientific opportunities; 3) assess the quality of measurement and longitudinal research methods in use across the 42 Network sites; 4) identify common problems in the implementation and management of ongoing reading intervention trials; and 5) address the need for formal, multidisciplinary training programs in reading psychology. This planning meeting included principal investigators from each site currently in the Reading Research Network, as well as representatives from the US Department of Education and the National Science Foundation (NSF). The meeting's discussions contributed to the development of Congressional testimony on the status of reading research that was presented before the US House Education and Work Force Committee (Lyon, 1997), the Senate Committee on Labor and Human Resources (Lyon, 1998a), the House Subcommittee addressing Title I reading programs (Lyon, 1998b), and the House Science Committee addressing the scientific quality of reading research (Lyon, 1999). In addition, the review of converging research findings, the identification of research gaps, and recommendations for future research were published and disseminated in peer-reviewed archival journals and books relevant to different audiences and consumers, including psychologists and educators (Lyon & Moats, 1998), educational policy makers (Fletcher & Lyon, 1998), reading educators (Lyon, 1998, 1999), researchers and clinicians in learning disabilities (Lyon, Alexander, & Yaffe, 1997), developmental neuroscientists (Lyon, 1998; Lyon & Rumsey, 1998), and pediatricians (Lyon & Shaywitz, 2000). Moreover, the determinations and recommendations derived from this strategic planning meeting served as the scientific foundation for the development and publication of a recent RFA, *Learning Disabilities: Multidisciplinary Research Centers*, to extend research in learning disabilities and to increase research in reading fluency and reading comprehension. The RFA also invites intervention research to improve instruction in these critical reading skills, as well as research in written language development and mathematics.

To address the significant gaps that continue to plague the understanding of mathematics development and mathematics cognition, a three-day strategic planning meeting was held April 8-10, 1999, at the NICHD. Participants included representatives from the NICHD, the US

Department of Education, the NSF, Army and Navy research programs, mathematics organizations, and researchers specializing in mathematics cognition, developmental neuroscience, neuroimaging, developmental psychology, educational psychology, and mathematics education. The meeting's discussion produced a well-thought-out plan to build a multidisciplinary research program developing new knowledge in understanding critical mathematics concepts, identifying and treating mathematics disabilities, and developing instructional strategies to effectively teach a wide range of mathematics skills and concepts. The proceedings and recommendations from this planning meeting were published in a major archival journal (Berch, 1999). Additionally, an RFA to stimulate research in areas identified at the April conference will be published in FY 2001.

RESEARCH HIGHLIGHTS

Learning to read is critical to a child's (and an adult's) well-being. The child and adult who cannot read at a comfortable level experience significant difficulties mastering many types of academic content, are at substantial risk for failure in school, and are frequently unable to reach their potential. The prevalence of reading failure in the United States is unacceptably high, with over 40 percent of fourth graders performing below basic levels in reading.

The CDBB Program in Human Learning and Learning Disabilities has continued to extend and support research in reading development, reading disabilities, and instructional approaches that enhance reading acquisition. Since 1965, this programmatic effort has grown from one reading research site at the Haskins Laboratories to a 42-site Network that involves 34,501 children, as well as 1,102 teachers instructing in 266 schools and 985 classrooms (See Appendix E). Sites within the NICHD Reading Research Network are located in 18 states and six foreign countries. A unique feature of this research network is that it is composed of investigators supported through Research Center Grants (P50), Program Project Grants (P01), Individual Research Grants (R01), Small Grants (R03), and Small Business Innovative Research (SBIR) Grants (R43/44). Despite the diversity of funding mechanisms, each research site typically houses a multidisciplinary research team (excluding R03 sites) including psychologists, educators, neuroscientists, physicians, geneticists, linguists, and developmental neuroimaging specialists. While many of the first reading research sites were established through RFAs and other solicitation mechanisms, since 1995 the Network has seen a 128 percent increase in investigator-initiated R01 and R03 grants that address reading-related topics. Irrespective of the funding mechanisms or the rationale for grant submissions, principal investigators from each site have formed, under the leadership of the NICHD, a Research Network that meets formally at least once, and frequently twice, a year to discuss critical research questions, methods, data and data interpretation, and dissemination. This process has resulted in a systematic plan to obtain converging evidence that bears on three major questions: 1) How do children learn to read—what are the critical environmental, experiential, cognitive, linguistic, genetic, neurobiological, and instructional conditions and factors that foster reading development? 2) Why do some children and adults have difficulties learning to read—which of these conditions and factors, if sub-optimal, impede the development of reading skills? 3) How can we help most children learn to read—which instructional approaches and strategies are most beneficial to which children at which specific stages of reading development?

The amount and quality of research knowledge obtained about reading development, reading disorders, and the prevention and remediation of reading deficits has been significant. Researchers now understand many of the critical cognitive, linguistic, and perceptual abilities that are necessary for reading development. Further, investigators are making significant progress in mapping the genetic and neurobiological underpinnings of these abilities. During the past five years, converging evidence derived from the NICHD Reading Research Network has led to the development of early screening measures that can identify, with over 85 percent accuracy, kindergarten children who are at risk for reading failure. In turn, early intervention and reading remediation trials at 11 sites within the network have developed treatment/instructional approaches that help all but five-to-seven percent of children attain average or above reading skills. The significance of this contribution is readily understandable given the here-to-fore persistent finding that over 40 percent of children have difficulties learning to read.

The quality and stability of these findings across sites provides the foundation for a most critical use of scientific research: the ability to transform the lives of human beings and the development of public health and educational policies to ensure that these benefits are available to all. In the past five years, the evidence obtained from NICHD-supported reading research has been presented in detail to governors and school boards in 22 different states, the White House, five Congressional committees, all major professional organizations concerned with reading development and instruction, the National Academy of Sciences, the National Research Council, the Institute of Medicine, 54 university and college teacher education programs, and 146 school systems across the country. Research evidence derived from the NICHD-supported reading research program served as the foundation for reading policies and practices in 16 states and has directly informed the formulation and passage of several Congressional bills designed to increase the quality of reading education in the United States. The translation of research to practice for the improvement of the lives of our nation's children is indeed a research highlight.

THE PROGRAM IN LANGUAGE, BILINGUALISM, AND BILITERACY DEVELOPMENT AND DISORDERS

SCIENTIFIC MISSION

The CDBB Program in Language, Bilingualism, and Biliteracy Development and Disorders conceptualizes, initiates, and supports scientific efforts designed to advance knowledge in normative language development, for both monolingual and bilingual situations. The program also addresses the development of biliteracy in individuals from early infancy through adolescence. In some cases, the program supports studies of adult bilingualism and biliteracy, as they inform the overall process of language acquisition and organization of language in the brain. Within this context, the program seeks to stimulate and support research relevant to the health and development of children and adolescents, with particular attention to the factors that promote or impede normal language development in one or more languages, the development of English literacy in English language learners, and the role of second/other languages as they affect the

process of language development. The program also supports training in the study of language, bilingualism, and biliteracy development and disorders, with an emphasis on the integration and application of theoretical and conceptual principles derived from psychology, cognitive neuroscience, and sociolinguistics, as well as reading education and quantitative and qualitative research methodologies.

FUNDING TRENDS

Research Grants. The Program in Language, Bilingualism, and Biliteracy Development and Disorders is a new program in CDBB for FY 1999. Formerly, language development and disorders research was a part of two different portfolios: the Program in Cognitive, Social, and Affective Development and the Program in Human Learning and Behavior (now the Program in Human Learning and Learning Disabilities). In FY 1999, as part of a restructuring effort in CDBB, the Program in Language, Bilingualism, and Biliteracy Development and Disorders was formed. The restructuring allows studies of normative, as well as disordered language development, to be grouped together into one research program with cross-linguistic studies of language and provides a home for the growing interest in bilingualism and biliteracy.

Since 1995, neither research funding nor the number of research grants supported in this scientific area has grown (see Figures 1 and 2). Funding estimates for this research program are based on grants specific to this scientific area, which were not included in a single research portfolio for the duration of the five-year reporting period. Over the past five years, a total of $14,015,849 was awarded for research projects (i.e., P01, R01, and R03) in this program area. In general, research funding for language development and disorders fluctuated around a mean level of funding of $2,803,170 per year. The number of active grants declined, from 16 in FY 1995, to 14 in FY 1999 (Table 4).

Of the research awards made over the five-year period in the language, bilingualism, and biliteracy area (Tables 15 and 16), the majority (92 percent) were R01s, representing $10,874,283 (77.6 percent of total research funding for this area). Of the total number of grants made, less than 20 percent were new awards, as opposed to either competing or non-competing continuation awards. The high proportion of non-competing continuations (more than 69 percent) in this research area serves to emphasize the importance of having formed a separate portfolio to give the area greater visibility and attention.

Language Development and Disorders. During the past five years, research in language development has been the largest scientific area funded within the program, representing approximately 97.5 percent of the total program portfolio. There has been little change in the distribution of funding mechanisms over the five fiscal years, with R01s as the largest category, consistently.

Funding for these projects totaled $13,669,726 between 1995-1999. Of the total projects, 23 percent were studies of infant language perception and 64 percent addressed cognitive and/or linguistic aspects of language development. Included among these were studies of

literacy, acoustics, phonetics or phonology, syntactic development, lexical development, comprehension, and language and cognition, as well as two studies on the neurologic aspects of language development.

Note that the topics listed above are somewhat arbitrary categorizations of primary focus, as many of the projects analyze more than one aspect of language development. Nine studies were cross-linguistic, looking at aspects of speech or language development across languages; in these studies, investigators analyzed the similarities and differences between languages, including English, Spanish, French, German, Swedish, Korean, and Chinese. Researchers look for characteristics in infant and early childhood language learning that might be universal (common to all languages). Seven projects dealt with individuals with educational, language, or hearing impairments.

To generate additional research activity in the area of language development and disorders, CDBB is organizing a workshop to take place in September 2000, entitled *Emergent and Early Literacy*. This workshop, organized collaboratively with the National Institute on Deafness and Other Communicative Disorders, the Office of Behavioral and Social Sciences Research, several offices of the US Department of Education, and the American Speech-Language-Hearing Association, will examine current research knowledge and gaps and forge an emergent and early literacy research agenda for all children, including those with disabilities and those who are language-minority children. The workshop should lead to future research initiatives, which are likely to be trans-NIH and trans-agency. Additional activities are in the planning phase. Further, CDBB will conduct a strategic planning activity during FY 2001 to incorporate advice from the scientific community.

Bilingualism and Biliteracy. During the past five fiscal years, only four projects had a bilingualism or biliteracy focus, with only one study which is counted in the research project line (i.e., P01, R01, or R03). In FY 1995, which was the last year of that biliteracy R01, the project was awarded $346,123, representing 2.5 percent of research dollars for the five-year period. The other three bilingualism/biliteracy projects included two SBIRs and one Minority Predoctoral Fellowship. Altogether, funds awarded from 1995-1999 for projects addressing bilingualism and biliteracy topics totaled $1,582,222, representing 9.7 percent of the total for the Program in Language, Bilingualism, and Biliteracy Development and Disorders.

To address the need for additional research in the bilingualism and biliteracy area, in FY 1999, the NICHD and the Office of Educational Research and Improvement (OERI)/US Department of Education jointly issued RFA HD99-012, *Development of English Literacy in Spanish-Speaking Children*. Applications were received in November of 1999, and were reviewed in April 2000. Awards will be made in FY 2000. As part of this activity, CDBB will hold annual principal investigator meetings, to form a Biliteracy Research Network and to obtain agreement on some common measures and methods across projects, since a major goal of the RFA is to develop convergent empirical evidence on the best approaches to teaching Spanish-speaking children to read English.

Also in FY 2000, CDBB, the Demographic and Behavioral Sciences Branch of the NICHD, and the National Institute on Aging, with co-funding from the Office of Research on Minority Health, will hold a workshop, *The Inclusion of Minority Language Data in National Studies*. The workshop will develop a best practices document and research agenda on issues, such as translation of survey instruments, which includes when and how they should be translated, whether there are threshold numbers of research subjects which make it cost-effective to translate instruments, and how to account for subjects when it is not. In addition, cultural issues which must be addressed in translations of instruments will be discussed.

Research Training. During the past five years, CDBB supported two institutional training grants (T32) focused specifically on training in psycholinguistics, only one of which is still active in FY 2000. This award provides training for six-to-eight predoctoral training positions and two postdoctoral positions. During the past five years, the cost of these training awards totaled $367,481, which represents 1.8 percent of the total portfolio funding.

The research training program also supported one minority predoctoral award (F31) and nine individual post-doctoral fellowships (F32), totaling $312,784 (see Table 15). For the past five fiscal years, fellowships comprised 1.6 percent of the portfolio's funding. These fellowships were awarded to young investigators conducting research on a variety of topics, including early language acquisition in both English-speaking and bilingual children, the development of phonological word recognition processes, lexical and syntactic development in infancy, structural cues in early language acquisition, prosodic cues in infant speech segmentation, the contribution of genetics to language acquisition, and the use of eye-tracking to investigate rapid access to verb meaning in children.

STRATEGIC PLAN

The newly formed Program in Language, Bilingualism, and Biliteracy Development and Disorders targets a cluster of language research areas that clearly need attention, as can be seen in the 1998 National Assessment of Educational Progress data (National Center for Educational Statistics, 1998), which indicates that 60 percent of Hispanic fourth graders and 46 percent of Hispanic eighth graders cannot read English at the basic level. Several initiatives are currently underway or are being planned to address the areas of early literacy, bilingualism, and the development of English literacy in Spanish-speaking children. In FY 2001, the Program in Language, Bilingualism, and Biliteracy Development and Disorders will engage in a strategic planning activity to formulate both a broad research agenda and to target specific areas for additional focused activities and initiatives.

RESEARCH HIGHLIGHTS

All children, unless something goes terribly awry, develop the ability to communicate, most of them through spoken language. They acquire this ability at a very young age and at an amazing pace. Yet researchers continue to puzzle over how this miracle of development and communication comes about. CDBB has a long history of funding studies that uncover the mysteries of language development, language impairment, and the neural organization of language. During the past five years, CDBB-funded researchers have made advances in understanding how infants acquire language, how language is organized in the brain, how brain studies might predict problems in language development, and whether humans as a species are alone in their ability to develop language.

Using a measure of infant attention, researchers at Northwestern University are studying the role of naming in object categorization and induction. This research has demonstrated that infants as young as 12-13 months distinguish between novel words presented as count nouns versus adjectives in fluent, infant-directed speech. These studies also indicated that young infants link count nouns specifically to commonalities that underlie object categories and that infants' expectations for count nouns may be more precise than for other word categories, such as adjectives, perhaps because the mappings for other word categories tend to be more variable, both across languages and across development. These findings concur with most current theories of language acquisition, which suggest that the noun category may be established earlier and through different mechanisms than other grammatical categories, and that the noun category underlies the establishment both of reference and of other grammatical categories. Based on studies of infants acquiring English, French, or Spanish, researchers found that performance on novel nouns was the same across all three languages. The evidence indicates that from the onset of language acquisition, powerful relations link linguistic and conceptual development; these linkages support the establishment of hierarchical systems of knowledge. Objects may vary across cultures, and words will vary across languages, but the fundamental process of mapping words to meaning is similar across both culture and language.

CDBB-supported researchers from the Massachusetts Institute of Technology (MIT) are conducting a high-density study of language development. Using data from more than 1,000 children under the age of three years and longitudinal data on 146 monozygotic and 86 dizygotic twins, researchers are examining the heritability of certain aspects of language development. Current results suggest that vocabulary growth is partly heritable. Specifically, monozygotic twins achieve vocabulary milestones in closer synchrony, have more similar vocabularies in terms of relative proportion of nouns, acquire new words at a more similar rate, and combine words productively in closer synchrony than do dizygotic twins. However, heritability is much higher for productive word combinations than for vocabulary, presumably because words can be learned only from the environment, while combining words into new combinations requires active mental processing. This variation may be due to genetic factors.

Information from these studies is complemented by studies of neurological patients with memory deficits, which demonstrate dissociation, where a weakness in memory in the presence of a less-impaired rule system made it more difficult for patients to produce an irregular past tense verb

(e.g., *told*) and made them more likely to produce errors of overregularization (e.g., *telled*). MIT researchers report similar findings in magnetoencephalographic measurements of brain activity during normal subjects' production of regular and irregular forms, which supports the theory that the acquisition of words and rules are separate processes that may be differentially disrupted in language disorders, and that these differences relate to differences in brain organization. Finally, their evidence suggests that timing in language development may be part of a genetically-influenced maturational clock, which may help explain why different children acquire language on different schedules.

Researchers at Southern Illinois University and the University of Kentucky now have longitudinal data on over 130 children, from the neonatal period through age 13 years, including both neurological (Auditory Evoked Potentials; AER) and behavioral data. The researchers used neurological data collected shortly after birth to identify children who were at risk for developing lower-than-average verbal performance skills, with 80 percent accuracy through eight years of age. In addition, evidence indicates that newborn AERs are highly predictive of whether children will fall into poor, average, or good reading groups. The implications of this research for early identification and preventive intervention are striking.

At the Language Research Center of Georgia State University, CDBB-supported researchers have been studying chimpanzees (*Pan troglodytes*) and bonobo apes (*Pan paniscus)* for nearly 30 years. The research demonstrates that, using a symbol keyboard and ape-human interaction, apes are capable of complex learning, symbolic thought, speech comprehension, and other basic dimensions of language, numeric skills, planning, and culture. In addition, these studies produced the first evidence that language-competent bonobos can provide some forms of translation between their vocal communications and human-developed lexical symbols to communicate with humans, both on request and spontaneously. The bonobos have also been observed to correct misinformation that is unintentionally transmitted by experimenters. This project continues to study the emergence of communication, as well as the making and use of stone tools by these primates.

The Program in Language, Bilingualism, and Biliteracy Development and Disorders continues to support studies on the developmental process of language acquisition from infancy through late adolescence. The program supports longitudinal and experimental studies, cross-linguistic research, studies of non-human primates, and studies of the neural correlates and neural organization of language. In addition, the bilingualism and biliteracy components of the program are expanding rapidly.

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FIGURES AND TABLES

Figure 1. Total Funding of Grants Supported by CDBB Programs: 1995-1999

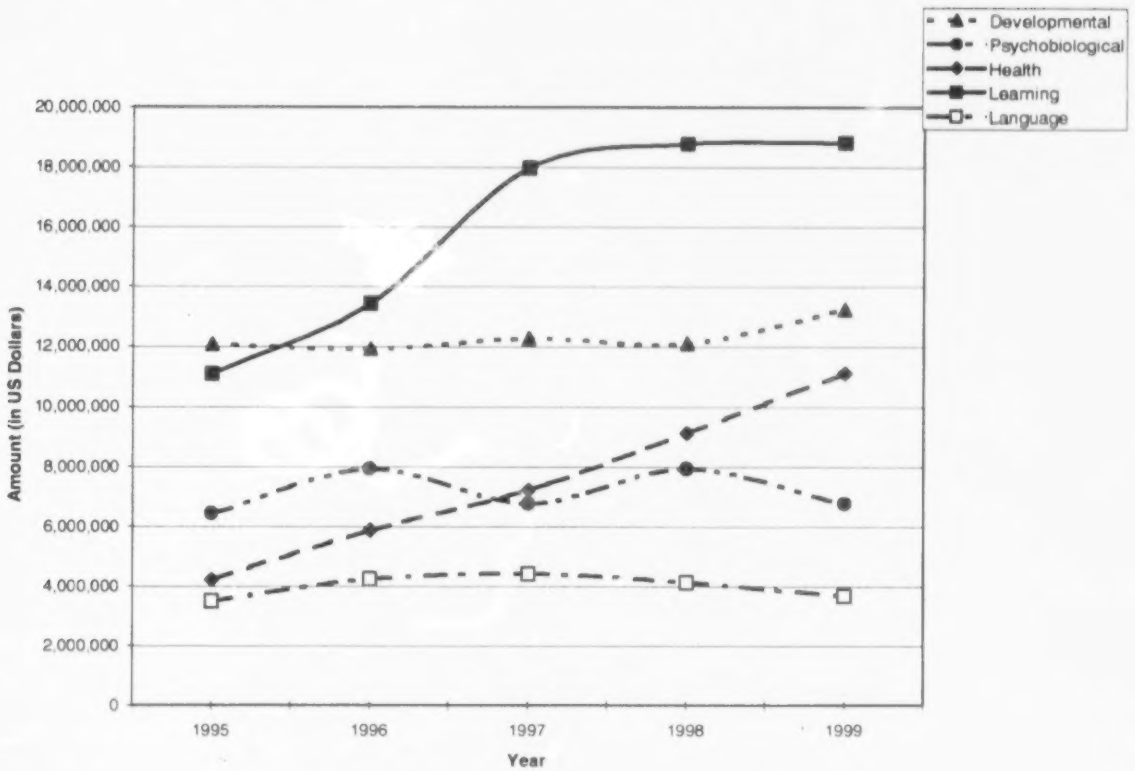

Table 1. Total Funding of Grants Supported by CDBB Programs: 1995-1999

Program	1995	1996	1997	1998	1999
Developmental	$12,085,070	$11,922,615	$12,268,407	$12,108,652	$13,242,486
Psychobiological	$6,417,267	$7,906,397	$6,765,109	$7,917,488	$6,744,901
Health	$4,450,094	$5,870,493	$7,212,560	$9,115,320	$11,111,127
Learning	$11,091,527	$13,441,083	$17,966,184	$18,786,098	$18,805,584
Language	$3,504,009	$4,236,969	$4,413,700	$4,130,187	$3,673,607
Total	**$37,547,967**	**$43,377,557**	**$48,625,960**	**$52,057,745**	**$53,577,705**

Figure 2. Total Number of Grants Supported by CDBB Programs: 1995-1999

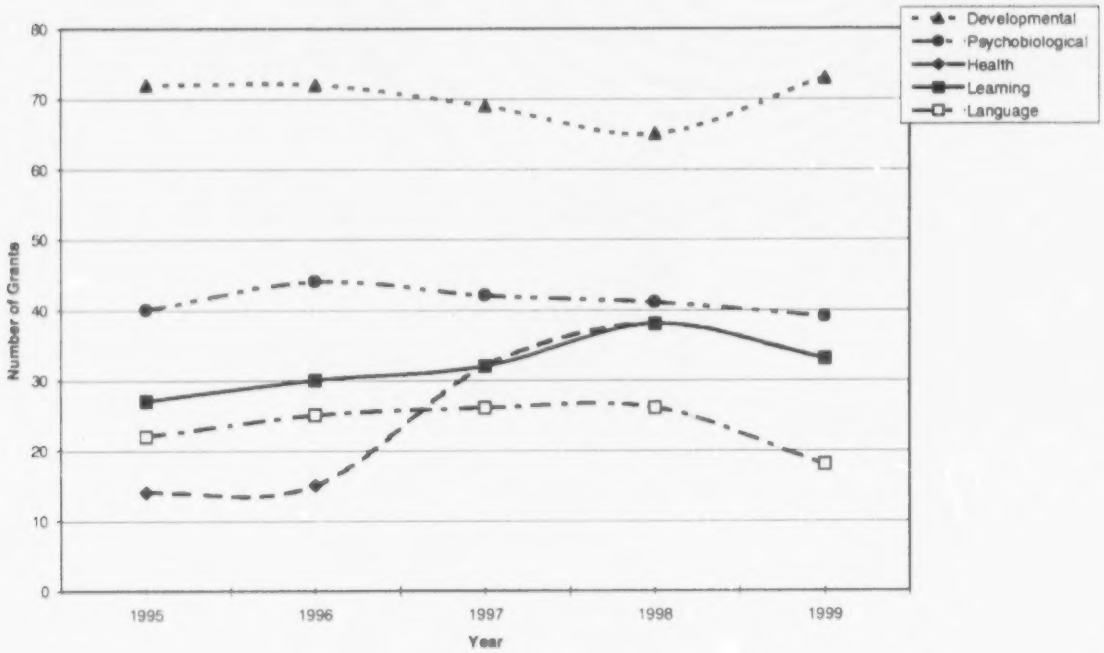

Table 2. Total Number of Grants Supported by CDBB Programs: 1995-1999

Program	1995	1996	1997	1998	1999
Developmental	72	72	69	73	73
Psychobiological	40	44	42	41	39
Health	14	15	32	38	35
Learning	27	30	32	38	33
Language	22	25	26	26	18
Total	**175**	**186**	**201**	**216**	**198**

Figure 3. Total Funding of Research Grants Supported by CDBB Programs: 1995-1999

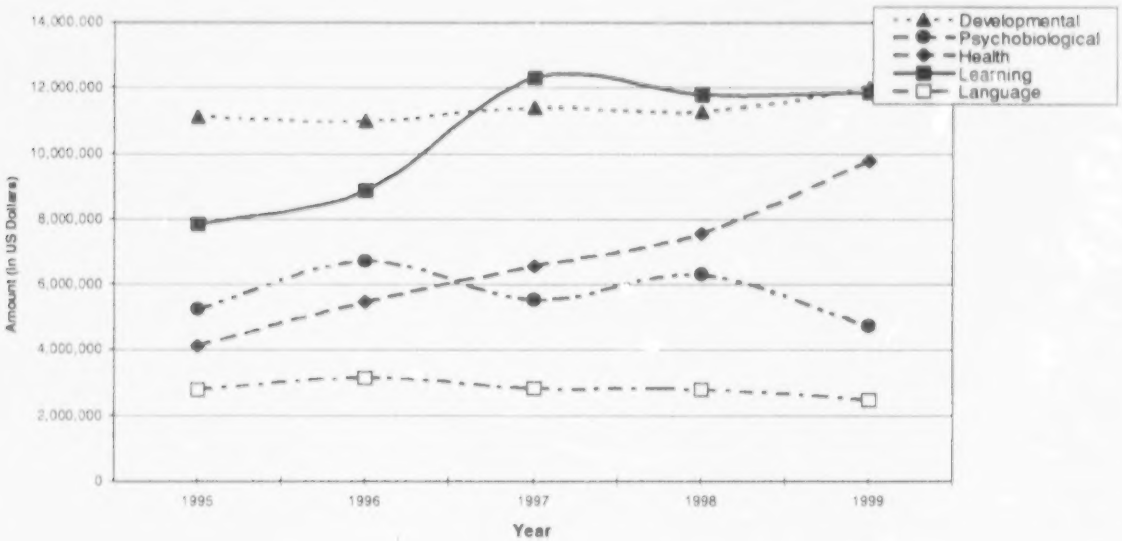

Table 3. Total Funding of Research Grants Supported by CDBB Programs: 1995-1999

Program	1995	1996	1997	1998	1999
Developmental	$9,770,372	$9,524,083	$10,314,290	$9,867,090	$10,717,144
Psychobiological	$5,226,529	$6,707,382	$5,535,783	$6,280,689	$4,714,694
Health	$4,101,429	$5,463,969	$6,563,813	$7,560,044	$9,765,179
Learning	$7,821,030	$8,855,440	$12,310,010	$11,786,751	$11,851,307
Language	$2,787,479	$3,136,985	$2,840,916	$2,784,579	$2,465,890
Total	**$29,706,839**	**$33,687,859**	**$37,564,812**	**$38,279,153**	**$39,514,214**

Figure 4. Total Number of Research Grants Supported by CDBB Programs: 1995-1999

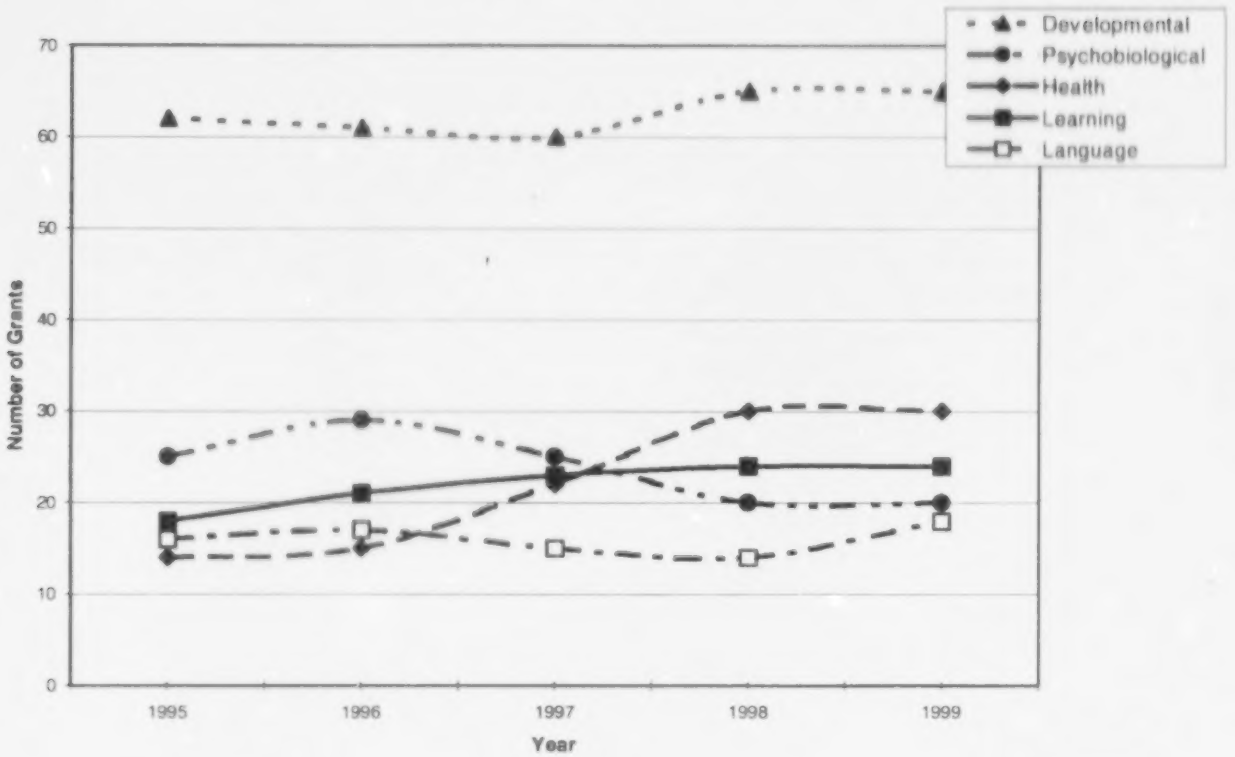

Table 4. Total Number of Research Grants Supported by CDBB Programs: 1995-1999

Program	1995	1996	1997	1998	1999
Developmental	51	48	45	44	45
Psychobiological	25	29	25	20	20
Health	12	13	17	22	32
Learning	18	21	23	24	24
Language	16	17	15	14	14
Total	**122**	**128**	**125**	**124**	**135**

Figure 5. Total Funding by Content Area for the Program in Cognitive, Social, and Affective Development: 1995-1999

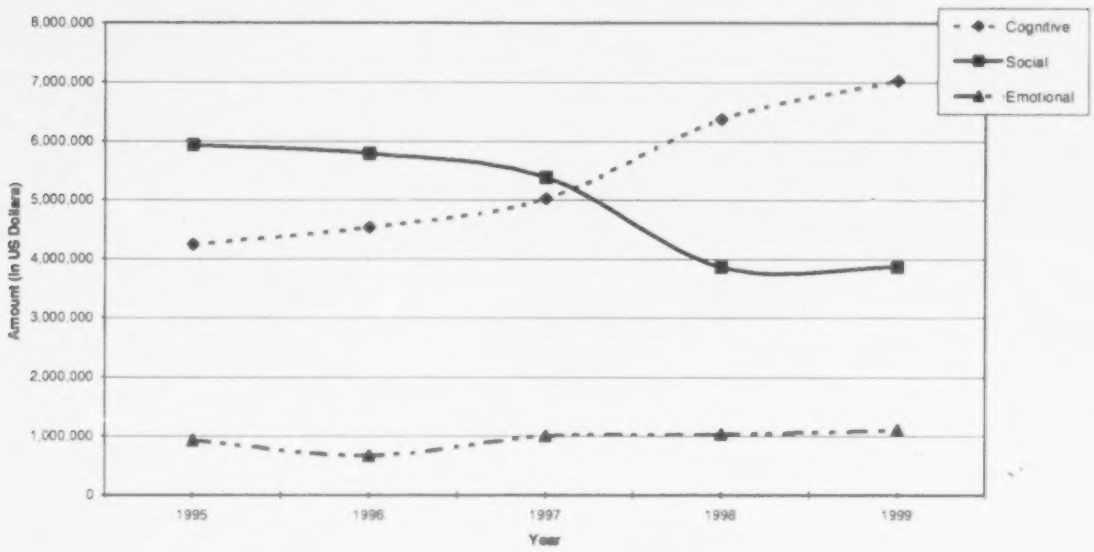

Table 5. Total Funding by Content Area for the Program in Cognitive, Social, and Affective Development (Excluding Training): 1995-1999

Content Area	1995	1996	1997	1998	1999
Cognitive	$4,242,946	$4,534,115	$5,024,863	$6,371,116	$7,024,023
Social	$5,928,454	$5,785,643	$5,380,923	$3,861,462	$3,858,167
Emotional	$925,804	$665,960	$1,000,330	$1,025,960	$1,092,657
Total	**$11,097,204**	**$10,985,718**	**$11,406,116**	**$11,258,538**	**$11,974,847**

Figure 6. Total Number of Grants by Content Area for the Program in Cognitive, Social, and Affective Development: 1995-1999

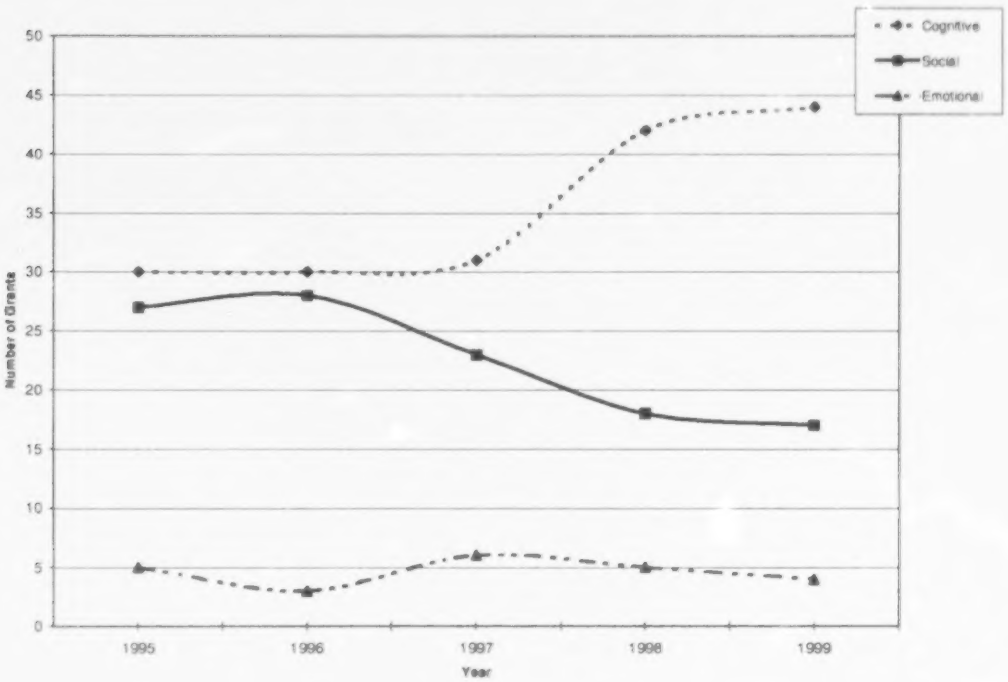

Table 6. Total Number of Grants by Content Area for the Program in Cognitive, Social, and Affective Development (Excluding Training): 1995-1999

Content Area	1995	1996	1997	1998	1999
Cognitive	30	30	31	42	44
Social	27	28	23	18	17
Emotional	5	3	6	5	4
Total	**62**	**61**	**60**	**65**	**65**

Table 7. Total Funding by Type of Grant for the Program in Cognitive, Social, and Affective Development: 1995-1999

Type of Grant	1995	1996	1997	1998	1999
R01	$9,770,372	$9,524,083	$10,022,637	$9,220,344	$10,054,501
R03	$0	$0	$291,653	$646,746	$662,643
Research Total	**$9,770,372**	**$9,524,083**	**$10,314,290**	**$9,867,090**	**$10,717,144**
SBIR	$370,335	$249,210	$99,348	$194,283	$0
Other Awards	$956,497	$1,212,425	$992,478	$1,197,165	$1,257,703
Training-Individual	$78,408	$123,116	$80,440	$88,220	$92,232
Training-Institution	$909,458	$813,781	$781,851	$761,894	$1,175,407
Total	**$12,085,070**	**11,922,615**	**$12,268,407**	**$12,108,652**	**$13,242,486**

Table 8. Total Number of Grants by Type of Grant for the Program in Cognitive, Social, and Affective Development: 1995-1999

Type of Grant	1995	1996	1997	1998	1999
R01	51	48	45	44	45
R03	0	0	4	9	9
Research Total	**51**	**48**	**49**	**53**	**54**
SBIR	2	1	1	2	0
Other Awards	9	12	10	10	11
Training-Individual	3	5	3	3	3
Training-Institution	7	6	6	5	5
Total	**72**	**72**	**69**	**73**	**73**

Table 9. Total Funding by Type of Grant for the Program in Developmental Psychobiology and Cognitive Neuroscience: 1995-1999

Type of Grant	1995	1996	1997	1998	1999
P01	$1,188,545	$1,955,626	$1,271,505	$726,514	$474,450
R01	$4,037,984	$4,751,756	$4,179,778	$5,469,675	$4,177,231
R03	$0	$0	$84,500	$84,500	$63,013
Research Total	**$5,226,529**	**$6,707,382**	**$5,535,783**	**$6,280,689**	**$4,714,694**
SBIRs	$0	$0	$0	$0	$40,948
Other Awards	$691,854	$582,489	$511,426	$782,419	$795,157
Training-Individual	$133,408	$178,917	$236,550	$351,027	$263,660
Training-Institution	$365,476	$437,609	$481,350	$503,353	$480,442
MRI Contract	$0	$0	$0	$0	450,000
Total	**$6,417,267**	**$7,906,397**	**$6,765,109**	**$7,917,488**	**$6,744,901**

Table 10. Total Number of Grants by Type of Grant for the Program in Developmental Psychobiology and Cognitive Neuroscience: 1995-1999

Type of Grant	1995	1996	1997	1998	1999
P01	2	3	3	1	1
R01	23	26	21	18	18
R03	0	0	1	1	1
Research Total	**25**	**29**	**25**	**20**	**20**
SBIRs	0	0	0	0	1
Other Awards	7	6	6	7	6
Training-Individual	5	5	7	10	7
Training-Institution	3	4	4	4	4
N01	0	0	0	0	1
Total	**40**	**44**	**42**	**41**	**39**

Table 11. Total Funding by Type of Grant for the Program in Behavioral Pediatrics and Health Promotion: 1995-1999

Type of Grant	1995	1996	1997	1998	1999
R01	$4,101,429	$5,463,969	$6,563,813	$7,484,634	$9,476,851
R03	$0	$0	$0	$75,410	$288,328
Research Total	**$4,101,429**	**$5,463,969**	**$6,563,813**	**$7,560,044**	**$9,765,179**
SBIR	$331,112	$366,030	$648,747	$1,393,300	$770,084
Other Awards	$17,553	$40,494	$0	$83,796	$270,042
Training-Institution	$0	$0	$0	$78,180	$305,822
Total	**$4,450,094**	**$5,870,493**	**$7,212,560**	**$9,115,320**	**$11,111,127**

Table 12. Number of Grants by Type of Grant for the Program in Behavioral Pediatrics and Health Promotion: 1995-1999

Type of Grant	1995	1996	1997	1998	1999
R01	12	13	17	21	28
R03	0	0	0	1	4
Research Total	**12**	**13**	**17**	**22**	**32**
SBIR	2	2	5	8	1
Other Awards	0	0	10	7	0
Training-Institution	0	0	0	1	2
Total	**14**	**15**	**32**	**38**	**35**

Table 13. Total Grant Funding for the Program in Human Learning and Learning Disabilities

Type of Grant	1995	1996	1997	1998	1999
P01	$5,097,538	$5,317,486	$5,475,351	$5,080,909	$3,698,822
R01	$2,723,492	$3,537,954	$6,834,659	$6,705,842	$8,011,138
R03	$0	$0	$0	$0	$141,347
Research Total	**$7,821,030**	**$8,855,440**	**$12,310,010**	**$11,786,751**	**$11,851,307**
P50	$2,828,792	$4,105,023	$4,680,548	$4,984,358	$5,777,248
SBIR	$419,097	$480,620	$975,626	$1,969,672	$1,120,123
Training-Individual	$22,608	$0	$0	$45,317	$56,906
Total	**$11,091,527**	**$13,441,083**	**$17,966,184**	**$18,786,098**	**$18,805,584**

Table 14. Total Number of Grants for the Program in Human Learning and Learning Disabilities

Type of Grant	1995	1996	1997	1998	1999
P01	4	4	4	4	3
R01	14	17	19	20	19
R03	0	0	0	0	2
Research Total	**18**	**21**	**23**	**24**	**24**
P50	3	4	4	4	4
SBIR	5	5	5	8	3
Training-Individual	1	0	0	2	2
Total	**27**	**30**	**32**	**38**	**33**

Table 15. Total Funding by Type of Grant for the Program in Language, Bilingualism, and Biliteracy Development and Disorders: 1995-1999

Type of Grant	1995	1996	1997	1998	1999
P01	$695,348	$732,733	$751,789	$781,467	$0
R01	$2,092,131	$2,404,252	$1,982,354	$2,003,112	$2,392,434
R03	$0	$0	$106,773	$0	$73,456
Research Total	**$2,787,479**	**$3,136,985**	**$2,840,916**	**$2,784,579**	**$2,465,890**
SBIRs	$99,958	$425,619	$803,637	$727,770	$989,086
Other Awards	$514,448	$530,415	$599,197	$470,246	$101,982
Training-Individual	$23,700	$64,308	$77,184	$147,592	$0
Training-Institution	$78,424	$79,642	$92,766	$0	$116,649
Total	**$3,504,009**	**$4,236,969**	**$4,413,700**	**$4,130,187**	**$3,673,607**

Table 16. Total Number of Grants by Type of Grant for the Program in Language, Bilingualism, and Biliteracy Development and Disorders: 1995-1999

Type of Grant	1995	1996	1997	1998	1999
P01	1	1	1	1	0
R01	15	16	13	13	13
R03	0	0	1	0	1
Research Total	**16**	**17**	**15**	**14**	**14**
SBIRs	1	1	3	4	2
Other Awards	3	3	4	2	1
Training-Individual	1	3	3	6	0
Training-Institution	1	1	1	0	1
Total	**22**	**25**	**26**	**26**	**18**

APPENDIX A: CONFERENCES AND WORKSHOPS 1995-1999

Attention, Memory, and Executive Function.....**October 1995**

Clinical Trials in Reading Intervention Research.....**March 1996**

Applied Behavior Analytic Approaches for Preventing AIDS Risks in Middle Childhood.....**January 1997**

Progress and Promise in the Behavioral Sciences at NICHD.....**March 1997**

The National Institute of Child Health/Learning Disabilities Association Conference.....**May 1997**

Fetal Behavioral Development.....**June 1997**

Mathematical Cognition: From Numerical Thinking to Mathematics Education.....**April 1997**

Reading Development and Instruction.....**April 1998**

Development of English Language Literacy in Spanish-Speaking Children.....**October 1998**

Emotion, Empathy, and the Development of Emotional Perception: Linkages to Behavior and Cognitive Functioning in Family and School Environments.....**September 1999**

Working Group Meeting on Youth Violence Research.....**October 1999**

Pediatric Neuroimaging.....**October 1999**

Classification and Definitional Issues in Child Abuse and Neglect.....**December 1999**

APPENDIX B: RESEARCH SOLICITATIONS FOR 1995-1999

REQUESTS FOR APPLICATIONS (RFAS) AND PROGRAM ANNOUNCEMENTS (PAS)

1995

RFA HD-95-005: Learning Disabilities: Multi-disciplinary Research Centers

1998

RFA OD-98-002: Innovative Approaches to Disease through Behavior Change

1999

- RFA HD-99-012: Development of English Literacy in Spanish-Speaking Children
- RFA HD-99-014: Prevention of Health Risk Behaviors in Middle Childhood
- RFA OD-99-006: Research on Child Neglect
- PA 99-133: Career Development Awards: Child Abuse and Neglect

REQUESTS FOR PROPOSALS

1998

- RFP NIMH-98-DM-0002 P.T.: Pediatric Brain MRI Database and Study of Normal Development: Central Coordinating Site
- RFP NIH-NINDS-98-13-P.T.: Pediatric Study Centers (PSC) for an MRI Study of Normal Brain Development

APPENDIX C: BRANCH BIOGRAPHIES

MARGARET FEERICK, PHD

Dr. Feerick is a developmental psychologist with a research background in child maltreatment and family violence. She received her doctorate from Cornell University in Developmental Psychology, with concentrations in Social and Personality Development and Developmental Psychopathology. Prior to joining the NICHD, Dr. Feerick held research positions on several NIH-funded projects. She also received several national fellowships, and awards, including an Individual National Research Service Award from the NIH and a Society for Research in Child Development Executive Branch Policy Fellowship. Dr. Feerick worked as director of development and contributions for an independent school in New York City and taught at both the elementary and junior high school levels. As part of CDBB, Dr. Feerick is responsible for a research and training Program in Cognitive, Social, and Affective Development, which includes research in child maltreatment and violence.

LISA FREUND, PHD

Dr. Freund is a developmental psychologist and cognitive neuroscientist who is known for her neuroimaging studies with children from different clinical populations and was an NICHD-supported scientist for several years. She has extensive training and experience in the fields of developmental neuroscience, developmental psychology, learning disorders, and behavioral and molecular genetics. Dr. Freund received her PhD from the University of Maryland in Applied Developmental Psychology and was previously an Associate Professor of Psychiatry at the Johns Hopkins University School of Medicine and Kennedy Krieger Institute. As part of the CDBB, Dr. Freund is responsible for a multifaceted research and training program that promotes investigations, both basic and applied, to gain a deeper understanding of the linkages between genes, the developing brain, and behavior.

LYNNE HAVERKOS, MD, MPH

Dr. Haverkos is a board-certified pediatrician with extensive clinical experience in behavioral medicine, ambulatory pediatrics, and adolescent medicine. She received her medical degree from the Medical College of Ohio, completed a fellowship in Ambulatory Pediatrics at the Children's Hospital of Pittsburgh, and received an MPH in Epidemiology from the University of Pittsburgh. As the program director for the Program in Behavioral Pediatrics and Health Promotion at CDBB, she is responsible for research and research training in behavioral pediatrics and the role of behavior in the promotion of health, growth, and development across the life span.

G. REID LYON, PHD

Dr. Lyon is a psychologist with extensive research and clinical experience in developmental neuropsychology, cognitive neuroscience (pediatric neuroimaging), and educational psychology. Prior to joining the NICHD as a research psychologist in 1991, Dr. Lyon was an NIH- and NSF-supported scientist who served on the faculty at Northwestern University and the University of

Vermont. He received his PhD from the University of New Mexico, with a dual concentration in Developmental Neuropsychology and Developmental Learning Disorders, followed by post-doctoral training in Developmental Neuroscience. Dr. Lyon serves as the Chief of CDBB and directs the research Program in Human Learning and Learning Disabilities, which includes research reading development and disorders.

PEGGY MCCARDLE, PHD, MPH
Dr. McCardle is a linguist and a certified speech-language pathologist. She received her PhD from Pennsylvania State University and MPH from the Uniformed Services University of the Health Sciences. Early in her career, Dr. McCardle was an elementary classroom teacher. She has held university faculty positions and hospital-based clinical positions and has published articles addressing various aspects of developmental psycholinguistics and issues in public health. At the NIH, she has served as a scientific review administrator and as a senior advisor to the Deputy Director for Extramural Research in the Office of the NIH Director. Currently, she serves as Associate Chief of CDBB and directs the research Program in Language, Bilingualism, and Biliteracy Development and Disorders.

APRIL BURTON
Ms. Burton has been with the Branch since 1999. As program assistant, she manages the administrative activities of CDBB, including conference planning, communications, travel, and grant and central file management. She is currently working toward her Bachelor's degree in Behavioral and Social Sciences at the University of Maryland, University College.

SHONTINA BATTLE
Ms. Battle joined the Branch in 2000, as the branch secretary. She assists the program directors of CDBB in their daily administrative tasks, as well as working with the program assistant in managing travel, conferences, grant files and other duties.

APPENDIX D: PUBLICATIONS BY CDBB PROGRAM SCIENTISTS, 1995-1999

(Note: Branch scientists appear in boldface type below)

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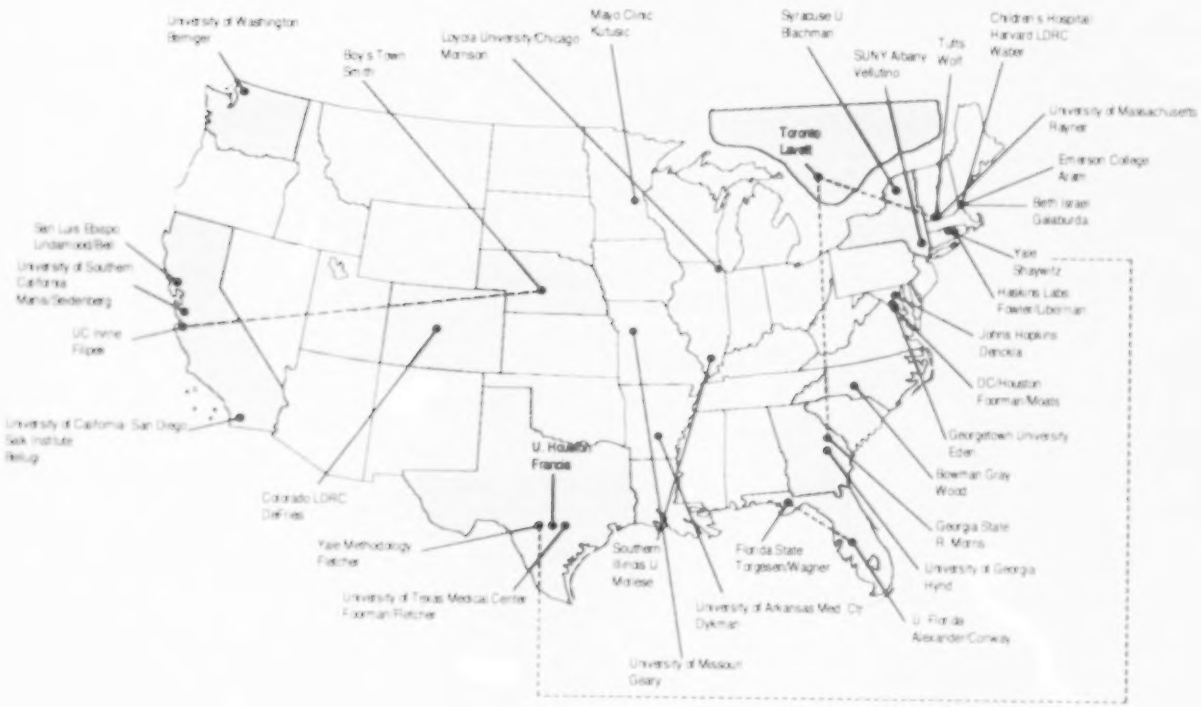
APPENDIX E: NICHD READING RESEARCH NETWORK SITES

NICHD Reading Research Program



• NICHD Sites

BEST COPY AVAILABLE